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Estimates given for the Construction and Maintenance of Telegraph Lines, and the Supply of Materials and Apparatus of every description.

are there a series of observations and experiments to be made, but we do not wish to treat this subject incidentally, though we must call attention to it.

We will merely say in passing that, as far as the physiological effects of continuous currents (we do not speak of the chemical actions) are concerned, the effects do not seem proportional to the intensity of the current. It is difficult, perhaps impossible, to lay down a precise law, but from personal researches, which will be described in future, we think we may conclude that the effects increase more rapidly than the intensity. We should not be surprised if the effects should prove to be proportional to the energy, or for a given conductor to the square of the intensity. But these conditions are not the same as those in which were produced the fatal accidents of which we are speaking, and it is useless to insist on them.

The study of the conditions under which the death of animals may be effected must lead to interesting results. Dr. Grange has begun these researches, and it will not be useless to indicate the facts which he has observed, and to which we shall shortly return.—*L'Electricien.*

KETTELL'S ELECTRIC CLOCK REGULATING MECHANISM.

IN the modern applications of electricity to the uses of practical life, the regulation of time is gradually assuming a prominent place. In the idea itself there is no novelty, for more than 30 years ago it was clearly shown by numerous experiments that several clocks could be driven synchronously by this new agent. The first attempts were, however, very incomplete, and nothing more than theoretical laboratory experiments came from them.

Defective construction, and the public's lack of acquaintance with electricity, and especially with the electric clock, accounts, in part, for the slow development of the system.

The manufacture of clocks has made great advances, and the mechanism of a modern timepiece is a wonder. But, however perfect a clock can be made, mechanical skill and science has not been able to produce a number of them which shall with certainty keep exactly together. In everyday life much dependence has not been put upon an exact measurement of time, but the greater the value that is put upon the latter, the more necessary becomes its exact measurement, and therefore the demand for *exact* time will make itself felt more and more.

Electric time-regulating devices can be described under one of three classes.

1. Those in which electricity is employed directly as the motive power for driving a number of dials from one regulator.
2. Those in which the electric current simply regulates the going of the clock at stated intervals.
3. Those in which electricity acts in the place of a weight or spring, the so-called electric pendulum clocks.

The first of these classes has been the one longest in use, and has been employed to some extent. Practice has, however, taught us the defects under which this system suffers. If overground wires are used disturbances are constantly occurring, and often after a severe storm we may find our time arrangements completely upset. In places where the wires can be laid underground much better results can be attained, and the wires have only the same liability to injury as have other wires conducting the electric current underground. In many cases, as, for example, upon a long stretch of railroad, it is not practicable to place the wires underground. Hence, in recent times, the greatest amount of work in the electric clock department has been turned to the second class, viz., those where electricity is employed to correct the irregularity in common clocks.

The third class finds very limited application, being expensive on account of the high class of workmanship necessary. The electric current is employed here simply to keep the pendulum moving at a nearly constant rate, an impulse being imparted to the pendulum when its amplitude of vibration falls below a given limit.

But, as mentioned above, it is to the second class that the attention of inventors has been mostly turned. Some new means have been devised, and several old instruments improved. Among the methods employed to regulate the going of ordinary clocks, one of the latest is that of Kettell, a description of which is as follows :—

Fig. 1 shows the device, A, as it appears attached to an ordinary clock, B. It consists of a train of wheels, similar to the striking-works of a clock, and where the clock already has striking arrangements these are employed to do the work of setting. Fig. 1 shows the apparatus as it is when arranged to be used on the same wire with the telegraph or telephone. M is an electro-magnet, *a* its armature, which is extended in the lever, *e*. The upper end of this lever, *e*, is bent, and catches the fly, *f*, of the train of wheel-work. *c* is a cam fastened to the wheel, *x*, and revolving with it. *y* is a piece carrying the two arms, *g*, *g*, pushed forward by the cam, C, acting upon the pin, *z*, fastened to *y*. *s*, *s*, are two grooved slips in which *y* moves freely.

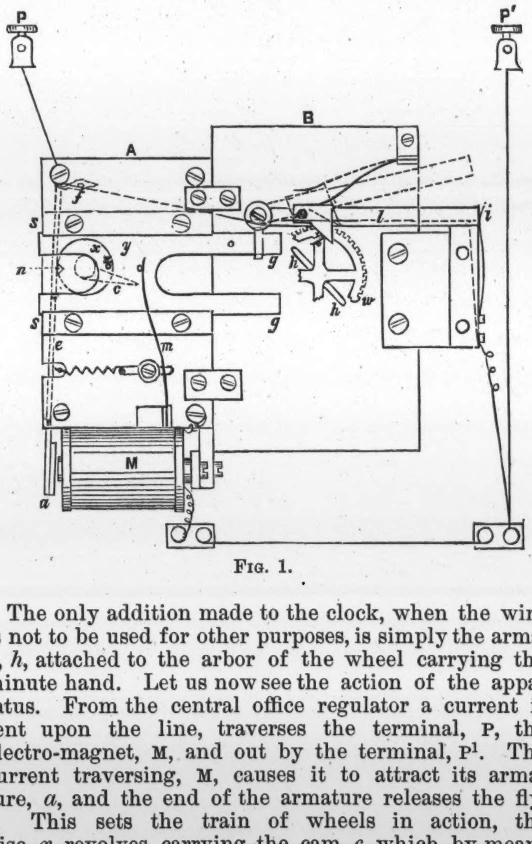


FIG. 1.

The only addition made to the clock, when the wire is not to be used for other purposes, is simply the arms, *h*, *h*, attached to the arbor of the wheel carrying the minute hand. Let us now see the action of the apparatus. From the central office regulator a current is sent upon the line, traverses the terminal, P, the electro-magnet, M, and out by the terminal, P^1. The current traversing, M, causes it to attract its armature, *a*, and the end of the armature releases the fly, *f*. This sets the train of wheels in action, the disc, *x*, revolves, carrying the cam, *c*, which by means of the pin, *z*, pushes the piece, *y*, forward. The arms, *g*, *g*, push with a gradual pressure against the pins, *h*, *h*, fastened to the arbor of the minute-hand, and thus urge the minute-hand exactly to the proper position on the dial. For instance, suppose in fig. 1 the minute-hand has to be set at right angles to the pins, *h*, *h*, with its point towards the right hand. If it were time for the clock to be regulated, fig. 1 would indicate the clock to be about seven minutes slow (provided the clock was regulated on the quarter hour). A current now being sent, the arms, *g*, *g*, would press upon *h*, *h*, and bring the minute-hand exactly to the quarter hour position. The spring, *m*, brings the piece, *y*, back into place ready for the next setting. The pin, *n*, catching in a notch of the wheel, *x*, prevents its revolving more than once.

If now the clock is to be placed upon a wire already in use for the telegraph or telephone, the only addition is the lever, *l*, and the spring, *i*, which is isolated from the remainder of the clock. Except during the short period required for correcting the clocks, the current enters by the terminal, P, traverses the lever, *l*, the spring, *i*, and the terminal, P^1. The resistance to the current by this course being practically nothing, only an exceedingly small part of the current traverses the shunted magnet, M, much too small to be in any way appreciable.

At the time, however, of regulating the clock, a pin, *p*, fixed to the wheel, *w*, carrying the hour hand raises the lever, *l*, from its connection with the spring, *i*. During this short interval the line is automatically broken in the central office regulator. When now the circuit is made by the central office regulator (the lever, *l*, being in the position indicated by the dotted lines) the current must traverse the electro-magnet, M, and the action of regulating is performed as described above. Fig. 2 shows very plainly the action of setting.

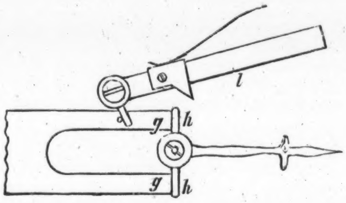


FIG. 2.

The advantages claimed for the new device are :—

1. Cheapness, the only cost being for the electro-magnet, M, and the train of wheels as used for the striking part of a clock. As said before, in case a striking device is already in the clock, this is used to do the work. No new clock is needed, as the device is fixed to any clock, converting a cheaply-made timepiece into an exact chronometer. Being so small, it is easily placed inside the finest parlour clock, and in no way injures its appearance, being entirely out of sight.

2. Great power available for setting the clock, the entire force of the striking spring being devoted to this end. No sticking of the hands or wheels are possible by this arrangement, and no blow is imparted to the clock, the action being a gradual pressure.

3. The small amount of current necessary. The action of the current is simply to attract the armature, *a*, of the magnet, M, the setting itself being a simple mechanical action. Only a very small battery is required as compared with other systems, and its action electrically is as certain and as easy as a Morse instrument.

4. The setting device being entirely separate from the clockwork itself, no disturbance can arise from fluctuations in the electric current. Should the circuit be broken, nothing further can happen than that the clock will not be regulated at the appointed time. The clock, however would keep its own time, the same as though no regulating device were there.

5. As shown above, it can be used on the same line with the telegraph and telephone instruments, thus avoiding the expense of running and maintaining an extra wire. This is an important consideration with railroad and telephone companies, enabling the latter to regulate their subscribers' clocks at a very small expense.

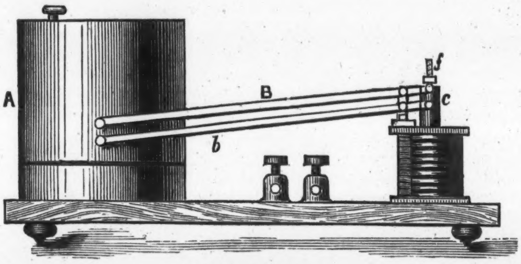
6. It being entirely automatic in its action, no attention is necessary after setting up the battery, any good battery lasting, as we know, for such work more than a year.

7. In case the clock to be regulated has a second hand, this is also set by a very ingenious arrangement, thus having hour, minute, and second hand exactly together.

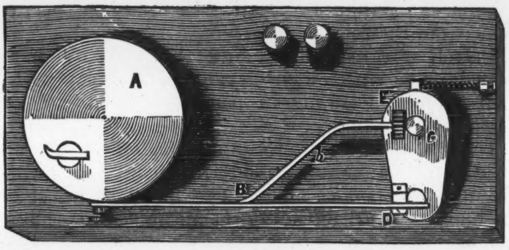
The apparatus is long out of its experimental stage, having been in use now over a year in America on several important railroads. On one of these it has been in most perfect operation during the last eighteen months over a distance of more than 100 miles.

WALKER'S ELECTRIC ENERGY RECORDER.

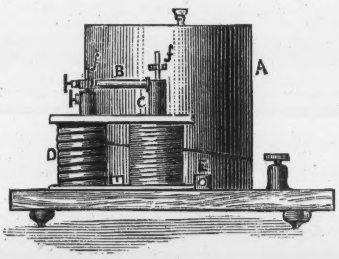
THIS instrument consists of a cylinder, A, which carries the paper for the diagram, and which is rotated by clockwork contained within it. Two solenoids, D and E, have movable cores, C, C^1, which are kept in position by suitable spiral springs inside the bobbins. One of these, D, is wound with thick wire, and the whole current of the circuit to be tested or measured, passes through it, while E is wound with fine wire of high resistance, and forms a shunt from the main circuit. The magnetism induced in D, tending to draw the core into the solenoid against the tension of the spiral spring, depends, of course, upon the current strength, and similarly the movements of E vary as the E.M.F. Two levers, B, *b*, carrying pencils, or self-inking styles, multiply and record the movements of the iron cores of the solenoids upon the revolving paper upon the cylinder, A.



SIDE VIEW.



PLAN.



END VIEW.

The levers can be adjusted to zero by means of the milled nuts, *f*, *f*, the springs being changed to suit the requirements of the test to be made. Thus the horizontal line of zero for B can be adjusted always above *b*.

This instrument is claimed as being very useful for automatically recording the efficiency of primary or secondary cells, the diagram being the true characteristic curve, and the sum of the two curves at any ordinate, being the electrical energy of the generator under test at that time. Scales are provided with each spring, so that the diagram is worked out in exactly the same way as one drawn by an ordinary steam engine indicator.

With a special 33 day clock train it is said to be a very efficient meter, indicating exactly the energy expended in a lighting circuit in a month, with the advantage of enabling the consumer to check waste, and actually see for himself the cost of his installation day by day, the instrument being enclosed in a locked case, having a plate glass front.

MEASUREMENTS OF CERTAIN COMPOUND DYNAMO MACHINES—R. J. GÜLCHER'S PATENT.

The subjoined measurements are communicated by M. Gülcher to a German contemporary.

Manufacturer's Number of Machine	Number showing Size.	Resistance in ohms.								Potential difference in volts.				Strength of current in ampères.		Work in horse-power.					
		Of magnets.				Of the armature.		Total internal resistance.													
		r_m main bobbins.		r_2 secondary bobbins.		r_a		ρ		Between clamps $(V_1 - V)$	Between brushes $(V_2 - V)$	Between ends of magnets $(V_2 - V_1)$	Total E M F: $E = J\rho + (V_1 - V)$	In secondary bobbins: $J_2 = \frac{(V_1 - V)}{r_2}$	Total strength of current in external circuit: $J = \frac{(V_1 - V)}{R}$	In outer circuit: $W_1 = J\frac{(V_1 - V)}{736}$	Loss of work in machine: $W_2 = \frac{J_\rho^2 + J(V_1 - V)}{736}$	Total electric work: $W = \frac{J_\rho^2 + J_2^2 r_2 + J(V_1 - V)}{736}$	Electric utilisation: $N = \frac{W_1}{W}$	Revolutions per minute.	Date of measurement.
		cold.	hot.	cold.	hot.	cold.	hot.	cold.	hot.												
																					1884.
36	2	0·115	0·138	23·012	24·50	0·152	0·175	0·267	0·313	64	71	7·0	76·52	2·61	40	3·48	0·91	4·39	0·79	1120	4. March.
38	3	0·062	0·068	25·698	27·673	0·079	0·090	0·141	0·158	64·5	70·53	6·03	75·09	2·33	67	5·87	1·17	7·04	0·83	970	10. March.
87	1	0·205	0·229	31·130	33·448	0·233	0·240	0·438	0·469	65	70·1	5·1	74·38	1·943	20	1·766	0·426	2·192	0·81	1440	4. April.
59	4	0·054	0·056	35·955	37·780	0·069	0·071	0·123	0·127	63	69·8	6·8	79·51	1·667	130	11·127	3·06	14·187	0·78	740	9. May.

REMARKS ON RELATIONS OF TENSION.

Measurement 4th March, 1884 :

$J = 0$ A. $(V_1 - V) = 63$ V.
„ $= 10$ to 25 A. „ $=$ constant 67 V.
„ $= 40$ A. „ $= 64$ V.

Measurement 10th March, 1884 :

$J = 0$ A. $(V_1 - V) = 62$ V.
„ $= 17$ A. „ $= 65$ V.
„ $= 30$ to 57 A. „ $=$ constant $65·4$ V.
„ $= 67$ A. „ $= 64·5$ V.

Measurement 4th April, 1884 :

$J = 0$ A. $(V_1 - V) = 64$ V.
„ $= 4·5$ to 20 A. „ $=$ constant 65 V.

Measurement 9th May, 1884 :

$J = 0$ A. $(V_1 - V) = 45$ V.
„ $= 24$ A. „ $= 63·3$ V.
„ $= 65$ A. „ $= 67$ V.
„ $= 70$ to 102 A. „ $=$ constant $66·2$ V.
„ $= 130$ A. „ $= 63$ V.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—MONTREAL, 1884.

(*Continued from page* 227.)

MECHANICAL SCIENCE SECTION.

SIR F. J. BRAMWELL, F.R.S., President of the Mechanical Science Section, in his address to the section, said :—With respect to the application by the engineer of electrical science, it is within the present generation that electricity has passed from the state of a somewhat neglected scientific abstraction into practical use ; first, by the establishment of the land telegraph, then by the development into the submarine cable, by means of which any one of us visitors here in Canada may be in instant communication with his own country, and may be so without a selfish exclusive occupation of the cable, for once more the application of science has solved that apparently impossible problem of employing a single wire to be at one and the same time the transmitter of multiple electric messages, and messages in opposite directions. Then, thanks to the application of Faraday's great discovery of induced electricity, there has been, during the last quarter of a century, the progressive development of the dynamo-machine, whereby the energy of ordinary motors such as steam engines, is converted into electrical energy, competent to deposit metals, to (as has already been said) fuse them, to light not only isolated buildings, but extensive areas of towns and cities, and to transmit power to a distance, whether for manufacturing purposes or for the railway or tramcar; and thus the miracle is performed of converting a waterfall into a source of light, as at Sir William Armstrong's house, or into the origin of power for a railway, as at the Giant's Causeway. To the application of electrical science is due the self-exciting of the dynamos and the construction of secondary batteries, enabling a development of electricity to be continued for many hours. In the United Kingdom, general electric lighting, that is to say, the lighting of large sections of a town from a central station, has been stopped by the most unwise, because most unjust, conditions imposed by the Government General Electric Lighting Act of 1882. A new and meritorious industry, which should have been granted the same privileges as are accorded to other industrial undertakings needing Parliamentary powers, was subjected to this most unjust condition : that at the end of 21 years the public authority of the town or place lighted should have the option of buying the undertaking for the then value of the mere materials, and that if the authority did not choose to purchase (for it was not bound to buy), at every subsequent five-year period this option should re-arise ; that is to say, that a new undertaking, which would require years for its general acceptance (for the public is slow to take up a novelty), was, after the experimental and non-paying stage had been passed, to be practically forthwith taken away for a mere fraction of the capital that had been outlaid if the undertaking paid, but was not to be taken away if it did not pay. Such, in spite of the teaching of Section F, is the condition to which our Government has arrived in respect of economic science. The next electrical matter I have to touch upon, that of the telephone and microphone, with which will for ever be associated the names of Graham-Bell, Edison, and Hughes, has, as regards the public use of the telephone, been all but similarly treated in the United Kingdom. It has been declared to be within the telegraphic monopoly given by Parliament to the Post Office nine years before the telephone was invented, and the power to use it depends entirely upon the grace and favour of the Post Office, a grace and favour not always accorded ; and even when accorded, coupled with limitations as to distance, and coupled with a condition of payment of 10 per cent. of the gross receipts by the companies to the Post Office, as a royalty ; and all this because Government has become a trader in electrical intelligence, and fears the competition of the telephone with its telegraphs.

THE PORTRUSH ELECTRIC RAILWAY.

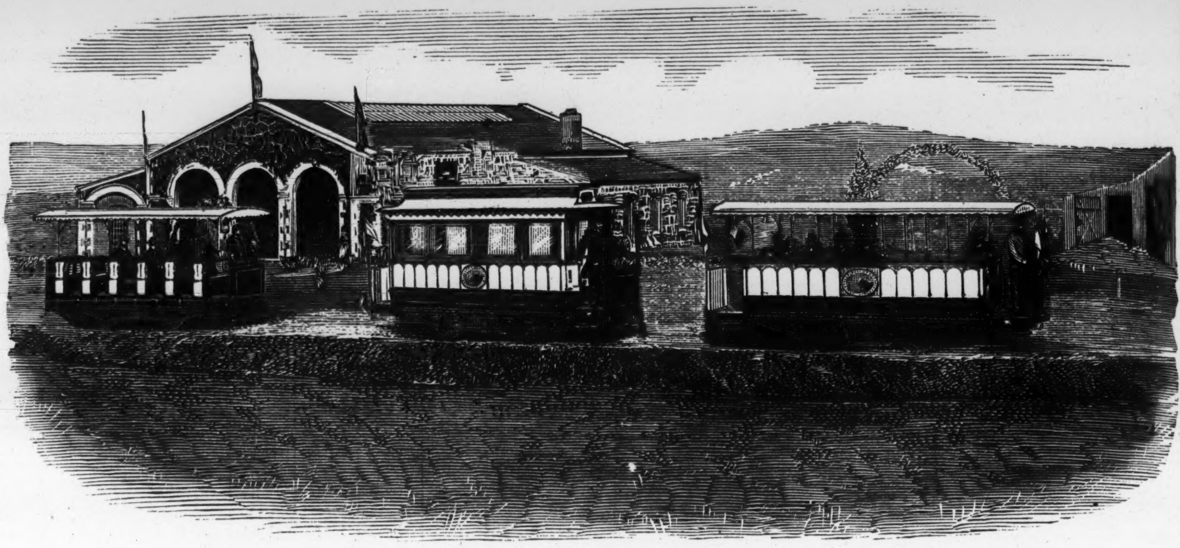
By ANTHONY TRAILL, LL.D., F.T.C.D., Chairman of the Company, and WM. A. TRAILL, C.E., M.A. Ing., Engineer of the Company, read before the British Association, September 1, 1884.

THE Giant's Causeway and Portrush Tramway was specially constructed with a view to the application of electricity as the motive power.

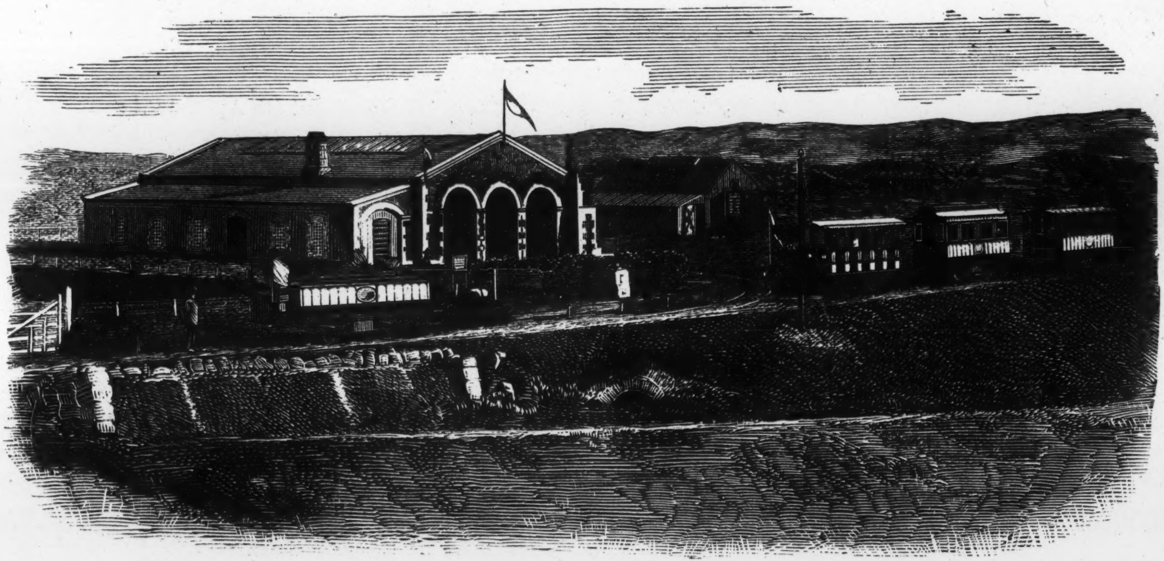
The tramway has several distinctive features by which it differs from tramways as usually constructed, and for the carrying out of these a special Act of Parliament was obtained.

The five chief points of difference are the following :—

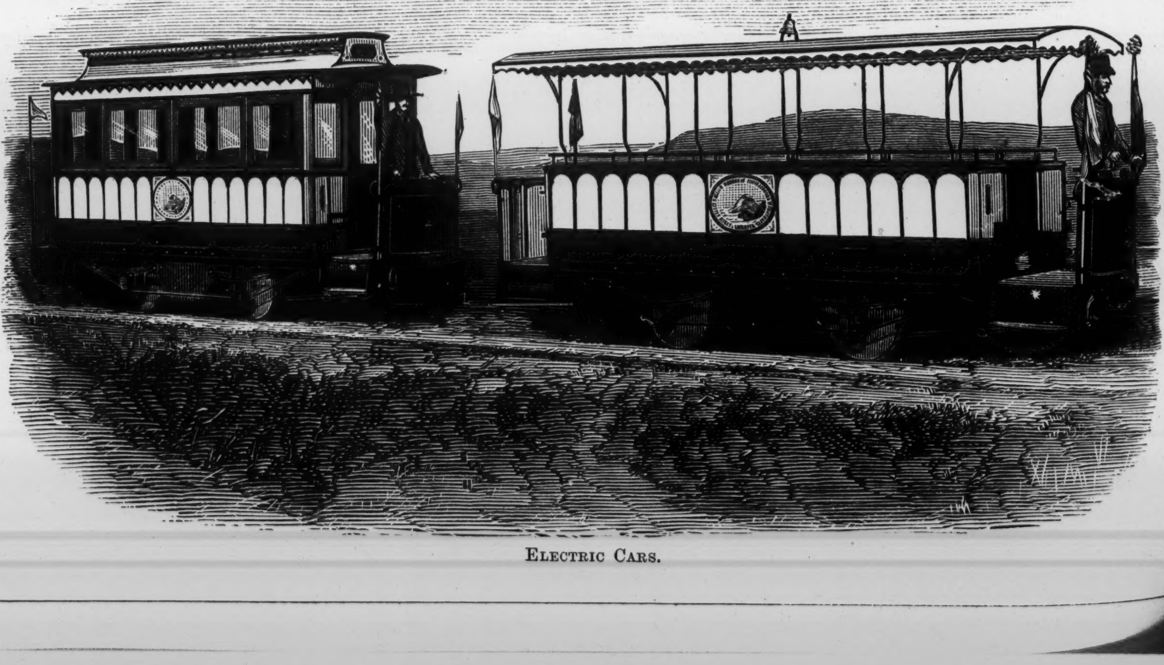
1. The gauge, which is 3 feet.



Electric Cars Ready to Start.



Tramway Depôt, Portrush.



Electric Cars.

2. The position of the tramway in respect to the road, viz., in its being placed along the side of the road and not in a central position, and being raised slightly above the surface of the road.

3. The form of the rail, a flange rail being substituted for a grooved rail.

4. The motive power, the application of electricity as the chief motive power for propelling the tram cars.

5. The use of water power as the actual source from which the motive power is derived.

The tramway is a narrow gauge single line throughout, with "turnouts," or passing places at intervals, of which there are nine, two terminal, and seven on the road.

It starts from the railway terminus of the Northern Counties Railway at Portrush, in the County Antrim, and runs along the magnificent coast road to Bushmills, a distance of six miles, and ends within a short distance of the Giant's Causeway. The total length of the tramway, including the branch tramway to the harbour at Portrush, and the several sidings is upward of seven miles.

The tramway is one continuous series of long inclines, gradients of 1 in 45 and 1 in 40 are frequent for upward of a mile in length, while steeper gradients of 1 in 30 exist for shorter distances, the worst gradient being 1 in 25. The summit level occurs about midway, at an elevation of about 160 feet above either terminus; the total rise from the depôt at Portrush to the summit being 203 feet.

Some sharp curves exist along the line, the worst one having a radius of about 40 feet.

The county road was increased in width from 24 feet to 27 feet 6 inches between the fences, and the tramway laid along the sea side of the road, on a slightly raised track or "trampath," with a granite kerbstone separating it from the roadway, for which a clear space of 20 feet was given. The track is gravelled up level with the rails, and forms an ordinary footpath.

For the short distances through the towns of Portrush and Bushmills the line has been laid with grooved rails 65 lbs. to the yard, and paved with square setts of basalt, constructed locally. In the greater portion of the line the rails used are flange rails of Bessemer steel, 42 lbs. to the yard, laid on cross sleepers, 2,000 to the mile, and fastened together with fish plates, dog spikes, and fang bolts, very similar in construction to the narrow gauge railways of the County Antrim.

There are seven "passing places" along the line, where the "points" are set so that the tramcars travelling in opposite directions always take their own sides respectively.

Just outside the town of Portrush the tramway depôt is situated, a handsome building of basaltic stone relieved with white brick mouldings, and from this place the trampath mode of construction commences, and also the working of the tramway by the electric motive power.

During the time of the perfecting of the electric working, and water-power generating station, the tramway was worked by two of Wilkinson's steam tramway engines, and the chief part of the goods traffic continues to be worked by them at present.

During the experimenting period the electricity was generated at the depôt by a small portable steam engine driving a Siemens dynamo.

The system finally adopted of utilising electricity as the motive power differs from the systems used on the Lichterfelde, the Charlottenburg, the Paris and the Zadkorod electric tramways, where overhead electric conductors or storage batteries were used.

On the Giant's Causeway electric tramway, the track being laid along the side of the road, a third rail or rigid electric conductor was placed along the toe of the fence or wall, consisting of from 20 to 30 feet lengths of T iron, weighing 19 lbs. to the yard, supported on short wooden posts with insulating caps of "insulite;" the top surface of the conductor rail being 3 inches wide and 18 inches above the level of the tramway rails.

This conductor rail is kept constantly charged with electricity from the dynamo at the generating station. The different lengths of the conductor rail are joined up with two U-shaped copper connections and fish plates; where breaks in the continuity of this rail are necessary — as at field gates and road crossings—the rail ends off at either side, and these are connected together by insulated cables laid underground across the gaps, so that the metallic continuity is preserved, the ends of the conductor being bevelled off.

The electricity in this conductor is never allowed to exceed 250 volts as a maximum, so that only slight shocks are experienced upon touching it with the hand.

The driving apparatus or dynamo in the tramcar is contained in a small enclosed box underneath the floor of the car; the electricity is taken from the conductor by two collectors or brushes, and is gradually turned on by a commutator starting handle, through several resistances to the dynamo, which is made to revolve in sympathy with the generating dynamo; the speed is reduced by spur gearing and a pitch chain, driving on to a toothed wheel upon the axle, whereby motion is communicated to the car, and a speed of 10 miles an hour readily obtained.

The electricity is taken from the conductor rail by means of two brushes or collectors (Traill's patent) placed at the ends of the cars, and wider apart than the gaps in the conductor rail, so that one collector is always in contact; these collectors are double concave steel springs shaped like a carriage spring, the wearing surface being protected with a steel shoe, which is easily renewable, but lasts for many months.

Each electric car is fitted with a starting handle at each end and with powerful brakes, also with an automatic brake and speed indicator, and is capable of drawing a second car behind it, with a total complement of 44 passengers comfortably seated.

During the experimental trials the generating dynamo was driven by a portable steam engine, the dynamo being a Siemens SD_0 machine, a pure shunt dynamo.

The electricity is now generated by water-power on the river Bush, situated at a distance of 1,600 yards from the nearest point of the tramway and 6½ miles from Portrush.

A fall of 26 feet head of water is used to drive two of Alcott's turbines, each capable of working up to 52 H.P.; these turbines are provided with friction clutches, and drive on to a single shaft, which communicates by belting with a SD_{00} generating Siemens dynamo. This is a compound dynamo, shunt and series wound, working at a speed of about 700 revolutions per minute, and generating a maximum potential of 250 volts with a current of 100 ampères.

This generator is connected with the conductor rail alongside the tramway by an underground insulated cable formed of 37 strand of copper wire fully insulated, and covered with 34 strand of copper wire, which outer casing is used for the return current, the tram rails being similarly used for the return current along the line, fastened with U copper bands, in addition to the fish plates.

The resistance in the cable connecting the generating dynamo with the conductor rail = ·5 ohm, and in the conductor rail from Bushmills to Portrush = 1·4 ohms; the total resistance from generating station to Portrush and back is therefore 1·9 ohms. The insulation resistance along the whole line varies from 500 ohms in wet to 1,000 ohms in dry weather, the total leakage along the line being 2·5 ampères = a loss of ¾ H.P.

The authors then described a number of experiments for working the electric cars in parallel and in series, the former being in general use, and the latter used when a long train was required at one time. Also the experiment of simultaneously working both generators, the one at Bushmills and the other at Portrush. One dynamo being a compound and the other a simple shunt machine, when worked together the pure shunt dynamo was overpowered, and a reversal in its rotation took place; when both were made pure shunt machines they worked in harmony.

A large-sized working model and diagrams illustrating the turbines and other details were exhibited.

The daily running of the electric cars commenced on November 5, 1883, from which date till July, 1884, upwards of 13,000 electrical train miles have been run‸ the working expenses of the electric train mile being 2½d. a mile as compared with 5½d. or 6d. per tram engine train mile, and the average cost of 10d. to 1s. per mile where horse-power is used.

Report of the Committee consisting of Mr. R. F. GLAZEBROOK, *Secretary,* Professor GARNETT, *and* Mr. H. TOMLINSON, *appointed for the purpose of constructing and issuing Practical Standards for use in Electrical Measurements.*

Presented to the British Association, September 1st, 1884.

THE Committee reports that during the year the construction and testing of standards of electrical resistance have been proceeded with.

The coils of 10, 100, 1,000 and 10,000 B. A. units mentioned in the last report have been compared with the standard unit coils. An account of the comparison made by the secretary, and Mr. Elsler, with a table of the values arrived at is given in Appendix I. Further experiments on the temperature coefficients of these coils are in progress. During the year twelve coils have been compared with the B. A. standards and certificates of time-values issued by the secretary.

A table of the values found is given in Appendix II.

At the Southport meeting of the Association a grant was made to defray the expense of procuring standards of resistance in terms of the ohm. At a meeting of the committee held in March, 1884, it was decided to defer the purchase of these till after the meeting of the Paris Congress, and a resolution was passed to the effect that: "In the event of the Paris Congress adopting any definite standard of resistance, standards be ordered for the committee in accordance with that value."

The Paris Congress adopted as a standard, to be called the "Legal Ohm," the resistance at 0° C. of a column of mercury 106 centimetres long and one square millimetre in section. The standard resistance at present in use being B. A. units it became necessary to assume a relation between the B. A. unit and the legal ohm in order to construct coils whose resistance should be one legal ohm. This relation has been determined by various observers with slightly different results, and a meeting of the committee was held on June 28th to consider the question. At this meeting the following resolution, proposed by Prof. W. G. Adams, seconded by Lord Rayleigh was carried: "That for the purpose of issuing practical standards of electrical resistance the number of B. A. units adopted as the resistance of a column of mercury 100 cm. in length, 1 square mm. in section, at 0° C, be ·9540."

Taking this number, then,

1 Legal ohm = 1·0112 B. A. units.
1 B. A. unit = ·9889 legal ohms.

Coils having respectively a resistance 1, 10, 100, and 1,000 and 10,000 legal ohms have been ordered, two of each value, so that by frequent comparison of one with the other an accident to either may be checked. These standards are to have their correct values at temperatures near 15° C.

The two one-ohm coils have been sent by the makers, and their testing is being proceeded with. When this is complete the committee will be in a position to test and certify to the values of coils in terms of the legal ohm.

It proposes that the certificate should run as follows: "This is to certify that the resistance coil x has been tested by the Electrical Standards Committee, and that its value at a temperature of A° Centigrade is P legal ohms. It has been assumed for the purposes of this comparison that one legal ohm is equal to 1·0112 B. A. units."

The coils will be stamped with the monogram and a reference number.

A portion of the grant has been expended in some additions to the wire bridge belonging to the committee which have added greatly to its utility, while two thermometers for the testing-room have been purchased.

The committee would ask, in conclusion, that it may be re-appointed, with the addition of the name of Mr. W. N. Shaw, in order to continue the work of issuing standards of resistance.

APPENDIX I.

On the Values of the B. A. Standards of Resistance greater than One B. A. Unit.

The coils of approximate value 10 B. A. units, marked Elliott Bros., No 66 and No 67, or, C.C.L., 20 and 21 respectively, were compared with the B. A. standard by the method described in the last report with the results given in table I. The coils were immersed in the water-bath, the temperature of which remained constant during each observation for some days before the measurements were made. The values thus found were used for the determination of the coils of higher resistance, the methods of the last report being employed in this case also. The insulation of the various parts of the apparatus was tested carefully. Each result given in the table is the mean of two or more determinations at the same temperature. The readings of the thermometer used were compared with those of a standard instrument.

TABLE I.

Mark of Coil.	Date.	Value found in B. A. U.	Temperature.
Elliott ... ... No. 66	July 5	10·0065	19°·1
C.C.L. 20	„ 7	10·0043	18°·3
Elliott ... ... No. 67	July 5	10·0060	19°·1
C.C.L. 21	„ 7	10·0043	18°·3
Elliott ... ... No. 68	July 24	100·038	16°·7
C.C.L. 22	August 11	100·115	19°·9
Elliott ... ... No. 69	July 24	100·024	16°·7
C.C.L. 23	August 11	100·097	19°·9
Elliott ... ... No. 70	July 26	999·74	15°·8
C.C.L. 24	August 11	1000·78	19°·9
Elliott ... ... No. 71	July 26	999·76	15°·8
C.C.L. 25	August 11	1000·74	19°·9
Elliott ... ... No. 72	...	...	...
C.C.L. 26	August 11	10006·2	19°·8
Elliott ... ... No. 73	...	...	...
C.C.L. 27	August 11	10007·1	19°·8

APPENDIX II.

Table giving the values of the coils tested for the committee in 1883–84.

Mark of Coil.	Certificate value.	Temperature.	Destination.
Elliott ... ... No. 95	·99936	13°·9	
C. U., 5 C.C.L. ... „ 51	1·00337	15°·	Prof. Stuart.
„ 6 C.C.L. ... „ 52	1·00237	15°·5	Prof. S. P. Thompson
Warden, 456 C.C.L. „ 53	·99920	15°·	Mason College.
Elliott, 19 C.C.L. „ 54	·99937	17°·7	Cavendish Lab'tory
„ 41 C.C.L. „ 55	·99950	13°·8	Messrs. Elliott Bros
„ 56 C.C.L. „ 56	·99949	13°·8	„ „
„ 113 C.C.L. „ 57	1·00000	13°·8	Professor Adams, King's College.
Simmons, 4 C.C.L. „ 58	1·00101	16°·3	Messrs. Simmons.
Elliott, No. 92 C.C.L. 59	1·00109	18°·	Philadelphia Exhib.
„ ... C.C.L. 60	1·00067	18°·1	„ „
„ ... C.C.L. 61	10·0163	19°·8	„ „

The American Association for the Advancement of Science.—Captain Bedford Pim, R.N., who was one of those who induced the British Association to meet this year at Montreal, says a Philadelphia paper, is engaged in trying to persuade officials of the American Association that it would be a good idea for the body to hold their annual convention in England in 1886 or 1887. So far the idea has not made much headway, but Captain Pim says he believes that he can induce the steamship companies to offer exceptionally low rates, in which event the association officers state that the plan might be a feasible one.

NOTE ON THE PERIODIC MODIFICATION OF ELECTROSTATIC INDUCTION.

By H. J. CARHART.

(Read before the American Association for the Advancement of Science, September 5, 1884.)

IN continuation of my magnetophone experiments of a year ago, I have applied the perforated metallic disc to static electricity for the production of sound. For this purpose a "static telephone" was needed, and I have to thank Prof. Dolbear for kindly placing one at my disposal.

A thin zinc disc, perforated with a circle of 24 half-inch holes, was mounted on a rotation apparatus, and placed near a Holtz machine, so that the brass ball of the positive electrode was very close to the circle of holes. On the other side of the disc was placed another ball, insulated and connected with one of the plates of the static telephone. The other plate was joined to earth. Upon working the machine, and turning the perforated disc, a musical note could be plainly heard after the telephone had become charged by a spark from the machine passing through a hole in the disc. The disc itself was not insulated. The Holtz machine could then be stopped, and the sound remained audible as long as the brass ball retained an appreciable charge. In this case the lines of static induction pass through the holes, and the ball connected with the telephone is acted upon inductively. The solid portions of the disc intervening, on the other hand, screens the ball from the inductive action. Hence a periodic modification of the induction taking place between the two balls, and a corresponding movement of the plates of the static telephone by an increase and decrease of attraction, thus giving rise to a musical sound.

SOME RELATIONS OF POSITIVE AND NEGATIVE ELECTRICITY.

By H. W. EATON.

(Read before the American Association for the Advancement of Science, September 8, 1884.)

IF a point connected with a Topler-Holtz, or any other powerful electrical machine, is brought to within about an eighth of an inch of a candle flame, the flame is blown out when the point is positive, but has only a slight depression in it when the point is negative. Many variations of the experiment with both candle and Bunsen burner flames were tried, but the most marked results were obtained by putting positive and negative points of opposite sides of the flame, the result being a depression opposite to the negative point and a hooked point of flame reaching out above, or at one side of this, and touching the negative electrode a short distance above its point. If the hook had appeared only above the negative point it might have been explained by a composition of two forces, viz., the upward draught of the flame and a current moving from the positive to the negative point; but when the points were not directly opposite, the hook appeared at one side.

With the candle flame grounded, the phenomena were nearly as marked, and with the candle insulated, there was still a slight depression opposite the negative point.

To test the question further, a piece of paper, about two inches square, was glued to the end of a piece of ebonite, and introduced between the knobbed tipped poles of a Topler-Holtz electrical machine whose Leyden jars had been removed. When the paper was brought near either pole, it was repelled until very near, when it was attracted and clung to the pole. If this were negative, the brush discharge pierced the paper, but if positive the discharge passed to the paper and from its edges to the negative knob.

Paper coated with stearine acted like a plate of ebonite.

When a strip of paper 3 inches by 1½ inches was used, and was brought near either pole, its top bent over toward the other pole. When one of the knobs was removed the repulsion from the blunt point, whether positive or negative, was much more marked than before. With both knobs removed, there was a slight repulsion near the positive pole, but none perceptible near the negative, and the paper adhered to neither point.

It having thus been proved that there was a discharge from both positive and negative poles, whether these were points or knobs, and that the positive discharge was the stronger, experiments on the nature of these discharges were next made.

Pointed carbon crayons and slips of paper soaked in a solution of chloride of copper or strontium were placed opposite a Bunsen burner flame.

The flame gave flashes of colour when the point was either positive or negative, but more frequently when the point was negative. With the burner between the knobs of the machine, and one knob covered with paper saturated with cupric chloride, the colouring of the flame when the paper was negative was the most marked.

One knob was next covered with paper coated with lampblack, and to the other was glued a clean flat piece of paper. When the blackened knob was negative, more lampblack was carried over than when it was positive, but a very loose coating on the blackened knob sometimes gave reverse results. Lead and charcoal points gave no results.

These results seem to indicate that the negative discharge is largely composed of particles of the pole.

The currents of air set in motion by the negative particles make the phenomena, two or three inches from the point, nearly similar for both positive and negative.

In the course of these experiments some other interesting phenomena were noticed.

1. When the paper sectors of a Topler-Holtz electrical machine were connected by a bad conductor, such as the hand, or an insulated wet string, the machine always reversed, but would not always do so when a wire was used. The phenomena corresponds to the oscillatory discharge of Leyden jars investigated by Fedderson, Oettingen and others, and seems to indicate a momentum in the discharge. The use of a poor conductor in making the connection prevents a return discharge.

The experiment will not succeed immediately on starting the machine, for the potential of the sectors is not then sufficiently high.

2. Sparks can be obtained between parts of the machine which have the same sign.

3. Various effects were found with a magnet, but tests showed these to be due to the magnet being a conductor. One of the knobs of a Topler-Holtz machine was removed, thus leaving a blunt point opposite a knob.

When the point was positive and grounded, the knob was pushed towards it till sparks passed between them. If the grounding wire were removed, then the sparks passed into a brush discharge. Replacing the wire caused the sparks to again appear, and so on *ad infinitum*.

Placing the wire on the negative knob has the same effect as removing it from the positive point.

4. From one to four points were placed opposite a knob. The result differed from those obtained with a single point only in that the brushes on the inner positive points were always smaller than on the outer ones, and usually bent out so as to join these before the knob was reached.

With one and two points on each pole the brushes were so short that no definite forms could be made out.

When a glass tube was placed over a positive point a glow was visible on the point, and brushes appeared on the edges of the tube.

When the Leyden jars were moved, and the poles consisted of two blunt parallel rods about a quarter of an inch apart, the discharge was chiefly at the negative pole, but passed to the positive when the negative rod was grounded.

RELATION BETWEEN THE ELECTROMOTIVE FORCE OF A DANIELL CELL AND THE STRENGTH OF THE ZINC SULPHATE SOLUTION.

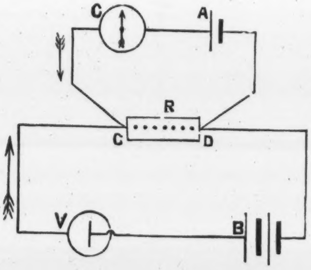
By H. S. CARHART.

(Paper read before the American Association for the Advancement of Science, September 5th, 1884.)

THIS investigation was carried out in the Physical laboratory of the University of Berlin in the spring of 1882, and was undertaken with a view to ascertain whether the variation in the strength of the zinc sulphate surrounding the zinc plate of a Daniell cell affected the electromotive force, and to what extent.

It is well known that different experimenters have found different values of the electromotive force of a Daniell cell. Thus Sir William Thomson found a value of 1·122 volts; Latimer Clark, 1·11; Kohlrausch, 1·138.* These different results are due partly to difference of method; but it is easy to demonstrate that slight changes in the condition of the plates or in the strength of the solutions modify the value of the electromotive force to an appreciable extent.

The method employed in this investigation was essentially the compensation method of Poggendorff.† The two poles of the battery, A, the electromotive force of which is required, are connected with two points, C, D, of a second circuit containing a battery, B, of higher electromotive force than A. The resistance between C and D is then varied by means of the rheostat, R, till no current flows through the circuit of battery A. The difference of potential between the points, C and D, is then the electromotive force to be measured. By Ohm's law the product of the resistance inserted between C and D and the strength of the current in the main circuit equals the difference of potential between the points, or the electromotive force of A.



The current was measured by a silver voltameter with pure nitrate of silver. The resistance employed at R was in Siemens units. The deposition of silver was continued for ten minutes; the cup was then washed with great care, dried in a hot air chamber, and weighed after cooling; fractions of milligrams being obtained by observing the swing of the pointer.

The Daniell cell consisted of a U tube of the form employed by Kohlrausch in measuring the resistance of electrolytes,‡ the bend of the tube being much smaller than the two branches. The lower portion was first filled with a saturated solution of zinc sulphate; saturated copper sulphate was then added to one branch and a percentage solution of zinc sulphate to the other. The sulphates were so added that the surface of separation between two solutions in contact was quite clear and sharp. This was effected by first placing a small disc of cardboard on the surface of the liquid in the tube and then carefully pouring the other liquid on it from a pipette. No sensible diffusion took place during the time required to make the observations.

The galvanometer in the circuit of A was a sensitive one, and was observed with a telescope and scale at a distance of about two metres. After a little experience a balance was readily obtained by the greater or less immersion of the silver plate in the nitrate of silver solution; and it was tested from time to time during the deposition of the silver and corrected if necessary. The galvanometer never showed a deflection of more than a few scale parts. The electromotive force of A was thus measured with minimum liability to polarisation and by a method entirely independent of the internal resistance of the cell. The only resistance required is that between C and D, which can easily be measured by means of a rheostat.

The temperature of the rheostat and of the cell was observed at every trial. The extreme limits of variation in the temperature of the cell was 3°·2 C.

The table exhibits the results; but the final deduction, as shown in the last column, was not made till after the recent report of the Paris Commission on the standard Ohm, and the publication of the results of Lord Rayleigh's experiments with the silver voltameter.* The values of the electromotive force in arbitrary units, given in the column next to the last, were reduced to volts as follows:—

The ratio of the Siemens unit to the Congress Ohm is 100 to 106, or 50 to 53. According to Lord Rayleigh, a current of one ampère deposits 4·025 gms. of silver in an hour or 67·08 mgs. a minute.

TABLE.

Per Cent. of Zn SO_4	Temp. of Rheostat.	Resistance in S.U.	Silver Deposited in One Minute.	Product of Resistance and Silver.	Corrected for Temperature of Rheostat.	Mean Value of E.M.F.	E.M.F. in Volts.
	Deg.		Mgs.				
0	20·	11	6·727	73·997	73·997	73·997	
1	18·8	11	7·277	80·037	80·000	80·000	1·125
3	18· 19·5	11 12	7·339 6·710	80·729 80·520	80·664 80·504	80·584	1·133
5	17·8 17·3	11 11	7·423 7·358	81·653 80·938	81·581 80·851	81·216	1·142
7½	17·3 18·3	11 11	7·239 7·250	79·632 79·750	79·546 79·694	79·620	1·120
10	17· 19·3	11 11	7·224 7·239	79·464 79·634	79·369 79·612	79·490	1·118
15	20· 18·3	11 11	7·219 7·205	79·409 79·255	79·409 79·201	79·305	1·115
20	17·3 17·5	11 11	7·170 7·210	78·870 79·310	78·785 79·231	79·008	1·111
25	16·3 16·6	11 11	7·199 7·184	79·189 79·030	79·072 78·923	78·997	1·111
						Mean ...	1·122

Therefore if C, R, and E represent current strength, resistance, and electromotive force in C.G.S. units, and *e* the electromotive force in the arbitrary unit of the table, we have the following equation:—

$$\mathrm{R}\,\frac{53}{50} \times \mathrm{C}\,(67{\cdot}08) = e;$$

whence

$$\mathrm{R\,C} = \frac{e}{\frac{53}{50} \times 67{\cdot}08} = \frac{e}{71{\cdot}105} = \mathrm{E}.$$

It is only necessary, then, to divide the quantities in column seven by 71·105 to reduce them to volts.

The method employed is amply sustained by the results obtained with a Latimer Clark standard cell.

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* "Everett's Units and Physical Constants," p. 146.

† Wiedemann's "Elektricität," p. 633.

‡ Wiedemann's "Elektricität," p. 590.

* *Nature*, March 20th, 1884, p. 495.

Two trials gave the same result; I give only one of them.

Time of deposition of silver	...	10 min.
Resistance interposed ...	...	20 S.U.
Temperature of rheostat ...	...	19°
" " Clark's cell	...	18°
Weight of silver cup after deposition		26·1963 gms.
" " before "		26·1453 "
Silver deposited in 10 min.	...	0·051 gms.
" " 1 min.	...	5·1 mgs.

$$5{\cdot}1 \times 20 = 102 = e$$
$$102 \div 71{\cdot}105 = 1{\cdot}434 = \text{E}.$$

The electromotive force of a Clark element is, therefore, 1·434 volts, the exact value given by Lord Rayleigh,* instead of the formerly accepted value of 1·457 volts.

The mean of all the values of the electromotive force in the last column of the table is 1·122, which is the value obtained by Sir William Thomson by the electrostatic method, if the velocity expressing the ratio between the electrostatic and electromagnetic units be taken as 3×10^{10}.

In a diagram the results of the investigation were set forth graphically; the ordinates represented the excess of the quantities in column seven of the table above 74, the value obtained with distilled water, while the corresponding abscissæ denoted percentages of zinc sulphate. It was observed that little variation in the value of the electromotive force occurs after reaching 10 per cent. of zinc sulphate, and that the maximum value appears to be at about five per cent. I have some reasons for doubting the accuracy of the larger of the two values found with the five per cent. solution. If the other value alone is employed the points laid off may be connected by nearly a plain curve. It thus appears that the variation in the concentration of the zinc sulphate solution is sufficient to account for the larger part of the discrepancy between the results obtained by different experimenters in measuring the electromotive force of a Daniell cell.

It would seem desirable, therefore, that a standard Daniell element should be so constructed as to admit of employing a zinc sulphate solution of known concentration. The form proposed by Professor G. F. Barker,† in which the solutions are saturated, appears to meet the requirements in this respect.

North-western University,
Evanston, Ill., *August*, 1884.

NOTE ON GRAMME'S RING AS AN INDUCTOR.

By M. A. GRAVIER.

WHEN a current enters by one of the brushes of Gramme's ring and issues by the other, traversing the conductive system which envelopes the core, we have, as is well known, an electro-magnet with two consecutive points, A and B, or, if it is preferred, we have a double magnetic circuit, closed in the air, internally and externally, as is shown in fig. 1.

If under these conditions of excitation we suppose a second circuit introduced, each section of this latter enters into two sections of the former; if, besides, we place a second pair of brushes following the line, *n*, *n'*, we shall have, in consequence of the effect of the rotation of the ring, an induced current, due to the displacement of the successive secondary coils of the ring in the magnetic field, determined by the first circuit, the poles of which are at A and B.

The yield of such a system will not be high, because the double magnetic circuit, A *n* B, A *n'* B, however well arranged it may be for the production of the magnetic field, is closed in the air, and the air is considerably more resisting than the metallic portion of the circuit.

To obtain the maximum yield we employ the following arrangement:—

The ring being constructed, as has been said, with a double circuit and two pairs of brushes, we coil upon it, inside and outside, a quantity of soft iron wire, sufficient to leave no longer, externally, any trace of magnetism.

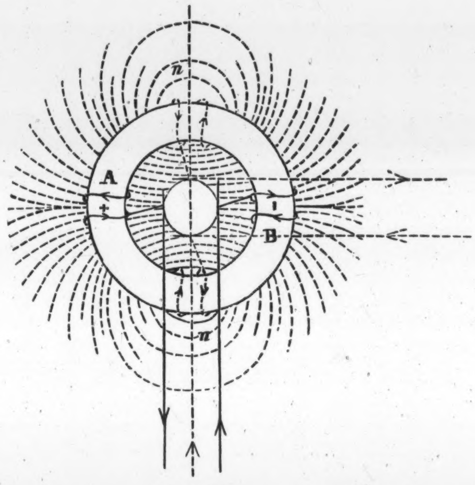

FIG. 1.

The magnetic field is thus at a maximum since it is completely closed.

The induced current in the secondary circuit is also at a maximum, for it is plain, according to fig. 2, that all the magnetic radiation, or all the lines of force of the magnetic field, emitted at A and B, will traverse with their full intensity the layers of copper spirals at *a a* and *b b*, and close themselves on the external metallic parts.

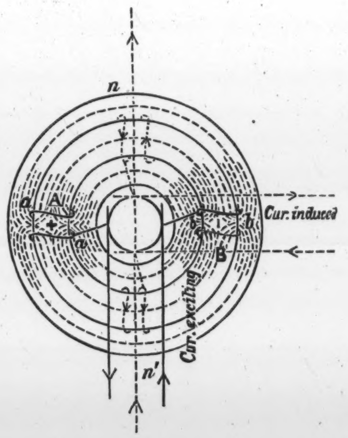

FIG. 2.

This apparatus is not a machine for generating electromotive force, but a machine which may be called a transformer of electric energy.

By means of certain modifications the apparatus just described may become an excellent machine for producing electromotive force.—*Bulletin de la Société Internationale des Electriciens.*

Telegraph Revenue.—The receipts from April 1st to September 20th, 1884, on the telegraph service were £835,000; against £830,000 received from April 1st to September 22nd, 1883.

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* *Nature*, March 20th, 1884, p. 495, in Lord Rayleigh's presidential address at Montreal, 1·435.

† Proc. American Philos. Soc., January 19th, 1883, p. 654.

THE ORGANISATION OF THE POST AND TELEGRAPH SERVICE IN FRANCE.

(*Continued from page 199.*)

THE international relations occupy an important place in the post and telegraph service; we therefore never left off trying to improve and to develope them.

Previous to the year 1876, the exchange of correspondence between France and the greater part of the foreign countries was regulated by special conventions, the clauses of which differed as well as the rates themselves.

As a general rule, the rates were calculated according to the distances travelled over, and ranged, for prepaid letters, between 30 and 70 centimes, and for objects, at reduced rates, between 3 and 18 centimes. As regards these latter objects, a complication arose, through having to apply for a same weight and an identical destination, different rates, according to the route followed and the nature of the object (newspapers, non-periodical printed matter, &c.).

Besides, the amount of the rates was divided in a variable proportion between the corresponding administrations, and consequently the accounts had to be kept in a minute and complicated manner.

The necessity of endeavouring to obtain the establishment of uniform rules in the international postal relations, was for the first time recognised at a conference held in Paris, in 1863.

The realisation of this idea was obtained through the adoption of common international rates by the convention of the General Postal Union, which was concluded at the Congress held in Berne, in 1874.

At that time, however, the financial condition of France was still too critical to allow of her immediately accepting the sacrifices which would result from her complete adherence to the resolutions of the union.

We had previously applied several of the rules adopted by the Congress of Berne to our conventions with Germany, Italy, the United States, and Spain; indeed, the basis of those treaties, as regards the absence of the dividing of rates, came close to the rule fixed by the convention of Berne for the exchanges between all the contracting States.

But we nevertheless hesitated, until M. Léon Say, appreciating the large benefits which would be obtained by us through entering the union, took the able initiative of proposing to the National Assembly to approve of the Convention of Berne.

The law was voted on the 3rd August, 1875. Thanks to the Minister of Finances, France entered the Postal Union on the 1st January, 1876, uniting her efforts to those of the other powers to realise with them a continual progress.

The Convention of Berne fixed a single rate for the exchange of the different kinds of correspondence between the different countries of Europe, and left to each State the amounts received by her; it did away with keeping account of the exchanges in the direct intercourses.

Since that time the prosperous condition of our finances has allowed our country to retake her place amongst those people who most actively go ahead in that direction, and when another postal congress was held in Paris, in 1878, France was no longer obliged to take a secondary part in it, as in 1874; she could boldly lead the other powers on to realise a considerable progress, by revising, improving, and completing the work of Berne.

The Congress of Berne had been a constituting one, but at the congress, opened in Paris, on the 1st May, 1878, the true organic laws of the universal Postal Union were determined.

At Berne, the number of adhering States was 22, representing a population of 350,000,000 inhabitants; in Paris, the plenipotentiaries of 33 States met together, representing a population of 653,000,000 inhabitants.

The general union of posts became the universal Postal Union.

The transit rates have been considerably reduced by the principal convention, owing to the sacrifices made by the maritime powers; this has rendered it possible to introduce in the rules of the universal Postal Union a uniformity of tariffs which has been highly appreciated by the public.

Considerable improvements have also been introduced in the international telegraph service.

The International Telegraphic Union which held in London, in 1879, its fifth conference, had been established in Paris, in 1865, on the initiative of France, thereby preceding the Postal Union by nine years.

The association, first formed between the European powers, successively gained the adherence of Persia, British India, Brazil, Egypt, and Japan. By thus extending its operation to countries belonging to different parts of the world, it greatly contributed to the development of international telegraphy.

The telegraphic relations between the different countries of Europe previously met with an obstacle not only in the high rates and the variety in those rates, but also in the want of uniformity in the rules which were applied to the exchange of telegrams.

The aim of the union has been to fix the general conditions of international rates and the rules for working international lines.

The union applied in 1879, after many modifications, the rate per 20 words for European relations.

During the interval of the Conference of St. Petersburg and that of London, an important change had taken place—the system of a word tariff which was scarcely mentioned in the Conference of Vienna, and was only admitted for extra-European communications in that of Rome, had been adopted by some of the great European Administrations.

France had applied it to her internal traffic; the rate being fixed at 5 centimes per word. This reform, which was received with great favour, produced from the first year of its introduction, an increase of 60 per cent. in the number of telegrams.

It was also admitted in the service with Algiers and in the telegraphic relations with Germany.

On their side, Germany, Austria, Hungary, Switzerland and Italy had adopted for their internal tariffs, if not the word rate pure and simple, at least the gradation per word, starting from a fixed number of words.

Under the influence of this current of public opinion, the principal object of the Conference of London was the discussion of the basis of the tariffs: Was the basis of a word rate, pure and simple, to be applied to all telegraphic relations of the union?

France upheld this idea. She tried to convince all the countries of this very liberal system, which has been the fertile principle of her internal tariff. If those ideas were not completely successful, because several States were afraid of a too large decrease in their telegraph receipts, our efforts, nevertheless, have largely contributed to important improvements.

The general principle of applying the word rate was adopted; full liberty was also granted as to the manner of charging the tariff thus fixed, for an average message of 15 words; finally, the right was given to all countries, whether neighbouring or not, to make special arrangements to modify the rates of the telegrams exchanged between them.

The word rate having been adopted, the next question was to determine the rates and the basis according to which these should be applied; for the rating per 20 words, we wished to see substituted a rating per word, fixed at the rate of the twentieth part of the price of the old message of 20 words.

The public would have gained to the greatest extent by the adoption of the new tariff, because it would have paid, under all circumstances, a rate exactly proportional to the length of the telegrams. It would never have been subjected, whatever the number of words might have been, to a higher rate than the one it previously used to pay.

The system, which after long and assiduous discussions has prevailed in the conference, consists of determining the price of telegrams per word for the whole of the route, adding to the amount obtained from the effective number of words a supplementary rate equal to the price of five words.

This arrangement immediately found its natural corrective in the liberty which, at our request, as stated before, was granted to all the Administrations to make special arrangements between themselves.

By making use of this power we have concluded special conventions with England, Italy, Spain, Luxemburg, Belgium, Switzerland, Portugal, Holland, Greece, and Roumania, thereby gaining both the adoption of the word rate, without limit, and an important reduction of rates, as compared with the old system, as well as with the general tariffs adopted in London.

We are trying to conclude similar arrangements with other countries.

We are enabled, from another reason, to apply the word rate, pure and simple, to all our relations. Article 21 of the service regulations allows of modifying the manner of rating, on condition that for 15 words the new rate will not deviate more than the one-fifteenth part of that resulting from the London tariffs.

We have therefore applied this system to our relations with those countries with which we had no special arrangements, viz., Denmark, Russia, Sweden and Norway, Servia, Austria, Turkey, and Bulgaria.

The rates thus determined are less by exactly the one-fifteenth part of the price fixed in London for a message of 15 words, but this deviation remains within the limits authorised by the conference.

Besides, all our rates, with the exception of our tariff with Luxemburg, are fixed at an exact multiple of 5 centimes, which facilitates the charging of them.

The impulse given to telegraphic correspondence by these measures has been such that with Italy, from the 1st June, 1882, and with Spain, from the 1st August, 1882, we have been able to arrange for a reduction in the rate from 25 to 21 centimes per word; this reduction was determined by conventions with those countries at the time when an increase of 20 per cent. in the receipts had been obtained as compared with the year 1878.

England had adopted, since 1840, the uniform rate of 10 centimes per single letter, but in France, the rate for letters, until in 1848, was determined according to the calculated distances between the offices of origin and destination.

On the proposal of M. Duclerc, a decree was voted, on the 24th August, 1848, by the National Assembly, authorising the uniformity of rates at the same time as the creation of postage stamps. The date on which these new regulations were to come into force was the 1st January, 1849.

The rate, at first fixed at 20 centimes per single letter of 7½ grammes, was raised to 25 centimes by the law of the 15th May, 1850, and on the 20th May, 1854, it was again reduced to 20 centimes. The law of the 28th June, 1861, fixed the weight of the single letter at 10 grammes. On the 24th August, 1871, the rate of single letters was raised to 25 centimes. This law, however, increased nearly all the postal rates, as the Posts, like all the other branches of the public revenue, had to contribute towards paying off the war debt.

After the first meeting of the Postal Union, held in Berne, on the 9th October, 1874, the maximum weight of ordinary letters was increased from 10 to 15 grammes, without any alteration in the rate of 25 centimes.

During these alterations in the rate of single letters passing from office to office, the rate of letters passing within the limit of one and the same office, which had been fixed at 10 centimes for a maximum weight of 7½ grammes by the law of the 3rd June, 1829, remained unaltered until the passing of the law of the 24th August, 1871, when it was increased to 15 centimes.

For letters from Paris to Paris, the limit of the weight was 15 grammes.

The law of the 3rd August, 1875, did away with this last difference by allowing to all single letters a maximum weight of 15 grammes.

The reform law of 1878 inaugurated the uniform tariff.

The postal reform of the 6th April, 1878, was the object in the Chambers of Deputies of three proposals for a law, emanating from the parliamentary initiative of four projects of the Government and of 10 amendments.

The Government, through M. Léon Say, Minister of Finances, had proposed on the 11th November, 1876, the return, pure and simple, of the rates in force previous to 1871.

Other proposals emanating from the parliamentary initiative had been made by MM. Lecesne and Talandier.

These different projects were simultaneously referred to the committee of the budget.

This committee was of opinion that the time had come to establish the uniformity of the tariff and to introduce a reduction, the influence of which made itself indisputably felt.

They proposed, therefore, to fix the uniform rate of single letters at 15 centimes.

Besides this, the report proposed different improvements, of which we intend speaking eventually at greater length. Several of these had been the object of special projects of the Government.

I had the honour, as general reporter of the committee of the budget of the Chamber of Deputies, to hand this report in on the 15th March, 1877; but the events of the 16th May, and the dissolution of the Chamber, delayed the realisation of those useful reforms.

During the next session M. Caillaux, Minister of Finances, feeling inclined towards the conclusions of the preceding committee of the budget, made them the basis of a new project for a law, which he presented to the Chamber of Deputies during the sitting of the 17th November, 1877.

On their side, the committee of the budget reproduced the preceding report and added to this, by voice of the same reporter:—

"In proposing to you the reform of the postal rates, we have thought to answer to the general wants of the industrious activity of the country and to facilitate our commercial relations. We do not doubt but that the result will gratify our hopes. The development of the postal receipts will not be long in justifying the measure."

The law was discussed and voted on the 11th March, 1878. The Chamber had successively rejected eight amendments, only adopting that of M. René Brice, referring to the supplements of newspapers.

The Financial Committee of the Senate entirely approved of the projected law as voted by the Chamber, and in a report of M. Cordier, handed in on the 28th March, 1878, stated that this reform was received with great satisfaction throughout the whole of France.

Finally, on the 2nd April, 1878, after having taken in consideration an amendment reducing still further the rate for the conveyance of newspapers, the Senate adopted this law unanimously. The Chamber of Deputies, to whom it was returned with this amendment, passed it with this alteration during the same sitting. The publication of it took place on the 6th April following.

The tariffs imposed by the law of the 6th April, 1878, may be summed up as follows:—

1. *Letters.*—A uniform rate of 15 centimes per 15 grammes for prepaid letters; 30 centimes per 15 grammes for unpaid letters.

2. *Postcards.*—A uniform rate of 10 centimes.

3. *Newspapers.*—Suppression of all distinction between political and non-political newspapers. A rate of two centimes per copy up to 25 grammes, with an increase of one centime for every 25 grammes, or fraction thereof, over weight.

Newspapers published in the departments of La Seine and Seine-et-Oise, and which circulate in the interior of their department only pay half this price.

Newspapers published in the other departments also pay only half those prices, when they circulate in the same department or in the neighbouring ones; but their weight may amount to 50 grammes, without having to pay more than one centime over 50 grammes; they pay an additional rate of one-half centime per 25 grammes, or fraction thereof.

4. *Printed matter, other than newspapers (in wrappers).*—A rate per parcel, bearing a private address, up to 20 grammes, one centime for every five grammes; from 20 to 50 grammes, five centimes; over 50 grammes, five centimes for every 50 grammes or fraction thereof. Suppression of the exceptional rate for electoral circulars and official reports of votes.

In open envelopes.—Five centimes per 50 grammes, or fraction thereof, for every parcel bearing a private address. Suppression of the monopoly of the post for the conveyance of newspapers and printed matter forwarded in wrappers, open envelopes, or in packets left open for free examination, whatever their weight may be.

5. *Declared values.*—A reduction from 20 to 10 centimes per 100 francs in the dues to be charged on declared values; a reduction from 20 to 10 centimes in the cost of the acknowledgment of the receipt of declared values, and of registered letters and other objects.

Such have been the liberal provisions of the law of the 6th April, 1878: it modified nearly all the postal rates. Finally we should add that the law of the 26th December following reduced from 50 to 25 centimes, the fixed dues to be paid for letters and parcels with declared values, and for registered letters.

(To be continued.)

HOUSE TO HOUSE ELECTRIC LIGHTING.

Report of the Surveyor to the Vestry of the Parish of Chelsea upon the Electric Lighting at Colchester.

In accordance with your instructions I have visited Colchester for the purpose of inspecting the system of electric lighting, which has been in operation in that borough since the 11th day of June last.

The installation was carried out and is maintained by the South Eastern Brush Electric Light and Power Company, who obtained a license from the Board of Trade. The system consists of private lighting only, that is to say, it is not at present extended to street lighting.

The area supplied is in the centre of the borough, and comprises Head Street, High Street, and Culver Street. The generating station is in a yard in the latter street, the engine for driving the two 40-light brush dynamo machines being of 25 H.P. nominal. I saw the machinery in full operation, and feel bound to add that there was no apparent cause of annoyance, and that similar stations might be established in any part of a town without creating inconvenience. The current is conveyed to six storage stations, five of which are ordinary cellars underneath street shops, and in which the necessary number of accumulators or secondary batteries are placed. The first set of accumulators is at the generating station, and the "cellar" stations are at about equal distances apart.

The cables are carried underneath the footways in a brick trench, 9 inches by 7½ inches, suitably arranged for drainage, and at the carriageway crossings the trench is deeper, and covered with a cast-iron cover, made in short lengths, and with flap joints. The cables and service wires are all suitably insulated and covered by lead coatings, and the service connections to the houses are laid in wooden troughs under the footways.

A safety fuse or cut-out, enclosed in a small box, is fixed to the conductor of each service line near the point of entrance to each house, which effectually interrupts the passage of the current in case of short circuiting. As the supply of electricity is constant, the light is always available, and by means of the switches it can easily be turned on or off either at the main or at any or either of the lamps, at the will of the consumer.

The system of supplying electricity by means of storage batteries certainly possesses the merit of economy, inasmuch as the cables for the supply of 2,000 glow or incandescent lamps of 20 candle-power each have cost but £1,200; whereas under the direct supply system the cost would probably have amounted to £7,000 or £8,000. The working of the system appears to be economical, as the operations are mainly carried on in the day-time; in fact, the current is entirely generated and the accumulators charged and tested during the day. It will therefore be observed that under this system the actual lighting is in no way dependent upon the moving machinery.

I have endeavoured to give a general outline of the system, and to avoid detailed descriptions of technical points; but I ought perhaps to state that immediately next to the exciter and dynamo machines, there are the volt meter, the ampère meter, and the regulator, together with alternate sets of rocking switches and batteries; any over-charging or injury to the latter being prevented by an automatic master cell. Practically the system is invented with a view to converting high electromotive force during charging to the standard electromotive force required for the lamps and by the rules of the Board of Trade which relate to standard pressure.

The shops and premises at present supplied with electricity within the area are about 30 in number. The lamps used are the incandescent lamps, which form of lamp certainly appears to be most convenient both for installation and lighting. The lamps are either suspended from neatly twisted conducting wires or mounted on the disused gas brackets or fittings, but the former plan is preferable. Most of the lamps are plain, but some are shaded, according to taste or the nature of the business. Of the various shops thus lighted I noted that the following businesses were supplied, viz., jewellers and silversmiths, tailors, clothiers, ironmongers, china and glass dealers, bootmakers, booksellers, hosiers, hatters, chemists, haberdashers, furniture dealers, and milliners, together with a large hotel and assembly rooms.

From inquiries I gathered that the advantages of the light are much appreciated, and after dark it was obvious that it was both steady and brilliant, and that the contrast with the shops lighted by gas was extremely unfavourable to the latter. In some shop windows two or three glow lamps show up the goods wonderfully well; but where six or seven were used the effect is splendid, every delicate colour being apparent and outside reflectors rendered quite superfluous.

The price of gas at Colchester is 4s. 6d. per thousand cubic feet, but the Electric Lighting Company supply the electric light at the rate of ½d. per lamp per hour, or 2d. per lamp per day and night in the summer and 3d. in the winter. Obviously until a greater number of the proprietors of the shops and premises within the area are practically convinced of the advantages of electricity, and act accordingly, the undertaking cannot succeed commercially; but at the same time the practicability of house-to-house lighting has been successfully demonstrated. The managing director estimates that if the whole 250 houses within the area took a reasonable amount of light, he would secure a profit of 14½ per cent. on the present basis. On the other hand, however, the fact must not be lost sight of that the light thus described might reasonably be deemed a luxury, inasmuch as light for light the price is equivalent to 33 per cent. more than gas.

On the whole, therefore, it may safely be asserted that since my reports on electric lighting in July, 1878, and December, 1882, a marked progress has been made in the system; and I am of opinion that the time has now arrived when the question might be considered by the electric lighting committee, with instructions to report upon the desirability or otherwise of taking any practical steps under the powers of "The Electric Lighting Act," with a view to the introduction of electricity into this parish.*

GEO. H. STAYTON, Assoc. M. Inst. C.E.,
Surveyor to the Vestry.

Vestry Hall, Chelsea,
Sept. 16th, 1884.

Overhead Telegraph Wires.—Judge Elcock's decision that a man has a right to cut telegraph wires which have been stretched over his premises without his permission, says the *Philadelphia Press*, accords with the spirit of the times, and should admonish telegraph companies that there are still private rights which they must respect. It is becoming plainer every month that overhead wires must go.

NOTES.

Electric Lighting.—Last week an important trial was made at the instigation of the Admiralty at Portsmouth, having reference to the practical utility of the electric light for side lights and mast-head lights on board Her Majesty's ships. The following gentlemen were present:—Captain Carr, H.M.S. *Crocodile*; Captain Douglas, H.M.S. *Serapis*; Captain Dyer, H.M.S. *Sultan*; Mr. Marshall, Assistant Constructor, Portsmouth dockyard, and other naval and dockyard officials, together with Mr. Lane, the electrician, Portsmouth, and the Edison and Swan Company's engineer. After arranging to place 50-candle-power Edison lamps in the ordinary port, starboard, and mast-head lanterns of H.M.S. *Crocodile*, and an ordinary oil light on the South-Eastern Railway jetty, alongside which the *Crocodile* is lying, as a standard to compare the electric light with, a launch, which was used in making the trial, proceeded to the *St. Vincent* training ship, a distance of about a mile, the electric light showing up in a most brilliant manner; and here a signal was made to the *Crocodile* to substitute 16 C.P. Edison lamps for those of 50 C.P., the oil lights remaining the same. Naturally, the result of this was to diminish the effect, but it enabled a little more careful comparison to be made between the electric light and the oil. When the 50 C.P. lights were in, the difference was so great that no fair comparison could be made out; with the 16 C.P. lamps in, the electric light appeared approximately to be twice as bright as the oil. The launch then steamed about another mile further off until she came abreast of the Clarence pier, when, owing to a slight haze, the oil light became invisible, while the electric light was still well in sight. The result of this trial was that the officers and other gentlemen present expressed their complete satisfaction as far as the illuminating power was concerned, and we believe it is confidently expected that the Admiralty will now generally adopt the use of electric signal lights on board the ships fitted with the necessary plant; and as the prejudice against the use of incandescent lights for signal lights has been, and still is, of a rather determined nature, we trust that this trial made by the Admiralty, and the opinion arrived at, will materially help in reducing the prejudice alluded to, and that we shall before long see all our large mercantile ships using electric signal lights.

The Town Council of Aberdeen, during the sittings of the Trades Union Congress last week, organised and carried out a successful conversazione, to which the delegates were invited. The electric lighting, under the superintendence of Mr. Spark, was a pleasing feature of the gathering. A 2,000 C.P. arc lamp was used, and during the whole evening the light was remarkably pure and steady. The motive power was supplied by a Pilsen dynamo-machine. Shunts were taken off the lamp leads and conveyed to the Square Room and used for other electrical experiments. Mr. Spark was assisted in his work by Mr. Esson, jun., who showed an electric motor driving machinery and fed from the electric light current. Prominent amongst the other attractions were telephone and telegraph apparatus, and in these much interest was displayed. Mr. J. D. Millar, manager of the Telephone Company, Aberdeen, had charge of the telephone department. Music was transmitted from a distance, and the working of a telephone exchange was shown and explained. A fire-alarm, by means of which the increasing temperature of a room or building on fire is indicated to the police, was also exhibited.

Edison's new ship lighting machine is said to be a great improvement upon earlier types. It gives current for 300 16 candle-power lamps at 110 volts with only 300 revolutions per minute.

Irleth and Askam, in Furness, North Lancashire, are far from gasworks and laying pipes would be a costly matter. Here then, says the *Mechanical World*, is a capital field for the introduction of electric light, especially as the neighbouring Roanhead mines are now lighted on the arc system. The Local Board has decided to adopt the incandescent system with Menzies' lamps.

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* The report was accordingly referred to the electric lighting committee.

The electric light is said to have been much more successfully applied during the German naval manœuvres just concluded than in former years.

The electric light is a great boon to fruit growers near the cities in California. At Los Angeles, it is reported, several bushels of moths are killed every night, while at Sacramento it is believed that the black beetle has been nearly exterminated.

The Park Lane Twist Company, Preston, has undertaken an improvement in its mill which must prove a great advantage in many ways. It was decided to fit up the greater portion of the buildings with the electric light, and the installation has been successfully carried out by Mr. Frederick D'A. Goold, of the "Volta" Electrical Works, Manchester. This is the first mill in Preston, we believe, in which the light has been introduced, and all concerned seem to be well satisfied with the results. There are 65 lights of 16-candle power; 24 are in the lower reeling room, 22 in the upper reeling room, 10 in the carding room, and 9 in the chapel reeling room. The dynamo machine is worked at an electromotive force of 90 volts. It is contended that in the great majority of cases there is an ample surplus of power in large works to drive all the machinery necessary for the production of the electric light, thus minimising the cost for maintenance, and under these conditions ensuring a far superior and more healthy light at a less cost than gas. The light is more brilliant, cheaper, and safer in a room where so much "fluff" is continually flying about.

An experiment was recently made at the Indian Ridge Colliery, near Shenandoah, by which the electric light was successfully introduced in a coal mine. The trial was made in a breast 30 feet in height and 40 feet broad, the distance from the shaft being 125 yards. Six Arnoux arc lights, of 2,000-candle power, were placed in the breast, the power being furnished by a 5-horse power engine. The entire chamber was brilliantly lighted; cracks and seams were plainly visible; and slate and coal could easily be distinguished from each other.

The Edison Company organised a central station on the Leipziger Strasse, Berlin, not long ago, for the purpose of supplying private buildings with the electric light. The Residenz and Court Theatres, in Munich, are also supplied with it. The latter city is the most fortunately situated in Germany with respect to the electric light, as the swift current of the Iser furnishes a terrific generating power. The prudent burghers, however, are content to await the result of introducing the electric light in other cities of "the Fatherland" before investing any of their hard-earned *silber groschen* in the enterprise.

Messrs. John Elder & Co. launched from their shipbuilding yard at Fairfield, Govan, a few days ago, a large steel screw-steamer, which has been built to the order of the Cunard Steamship Company, Limited, for their line of steamers running between Liverpool and New York. This steamer is a sister to the ss. *Umbria*, launched by Messrs. Elder on the 25th June this year. The dimensions of the vessel are:—Length over all, 520 feet; breadth (extreme), 57 feet 3 inches; depth to upper deck, 41 feet, and to promenade deck 49 feet, with a gross tonnage of about 8,000 tons. The whole of the entrances, corridors, chart room, saloon, music saloon, smoking saloon, ladies' saloon, captain's room, engine-room, &c., will be lighted throughout with a complete installation of the electric light on the incandescent principle. The greatest care has been taken in the lighting, ventilation, and sanitary arrangements throughout. The vessel, as it left the ways, was named the *Etruria* by her Grace the Duchess of Manchester.

Commenting upon the report presented to the Chelsea Vestry upon the house-to-house electric lighting at Colchester by Mr. G. H. Stayton, which we publish elsewhere in our columns this week, the *Chelsea News* says:—"The revocation of the Provisional Order by which the Metropolitan (Brush) Electric Light Company were to introduce electricity into Chelsea, upon the very favourable terms obtained by Mr. Mossop and his confreres at the Vestry, has been a source of disappointment to many, but hopes are still entertained that sooner or later the electric light will be introduced into the parish."

It may be remembered that at a stormy meeting of the South African Brush Electric Light and Power Company, held at the City Terminus Hotel in January last, the Chairman, Lieutenant-Colonel George Coxon, alluding to affairs at the Cape, said, "The company had at present at Kimberley about £5,000 or £7,000 worth of plant, and he should say it was worth the price of old iron." That was not a bad estimate, says the *Financial News*, for the Kimberley Town Council at their last meeting decided not to take the plant over.

The contract for lighting the new and old buildings of the London Stock Exchange has been entrusted to Messrs. Woodhouse and Rawson, of No. 11, Queen Victoria Street, E.C., and the work is to be proceeded with at once.

Messrs. Woodhouse and Rawson have also several other contracts on hand, among the principal of which may be mentioned Messrs. Guinness's Brewery, Dublin; Messrs. Ambuhl, Loebell & Co.'s, Hamburg; Messrs. Keyser & Co.'s, Cornhill; they have also the following private country residences—Gortmore House, Dundrum, Co. Dublin, the residence of E. J. Burke, Esq.; Paddockhurst, Worth, Sussex, belonging to Robert Whitehead, Esq.; and Colonel Fremantle's residence, The Chuffs, at Maidenhead.

Telephone Exchange for Inverness.—Arrangements have just been completed for starting a telephone exchange in Inverness.

The National Telephone Company in Leeds.—We have received the list of subscribers to the Leeds Exchange of the National Telephone Company. It is printed in pamphlet form, containing, besides, complete instructions as to the use of the instrument and interesting information respecting its progress. The first telephone, according to this authority, was placed in Leeds about October, 1879, and there are now in operation about 300 exchange and 40 private lines. The subscribers' list of this company is receiving daily additions.

Telegraphing to Australia.—We see in the *Melbourne Argus* that the telegram announcing the result of the race for the Goodwood Cup occupied only one hour and fifty-three minutes in transmission from London to Melbourne. This telegram went by the Indo-European Company's line across the Continent through Persia to Bombay, where it was transferred to the Eastern Extension Company's line, and thence proceeded to Madras, Penang, Singapore, Port Darwin, and across the Australian Continent to Melbourne. This despatch passed through some 14,000 miles of telegraph lines and cable, and was received and retransmitted between twenty and thirty times. The previous best record was telegraphing the first Hanlan-Trickett race for the acquatic championship, which went from London to Melbourne in two hours.

Cable Notes.—The Philadelphia and Seaboard Telegraph Company have laid a second cable between Philadelphia and Camden, containing ten copper wires. The company owns all the inventions of George B. Pennock, including underground conduits, submarine and aerial cables. Mr. Pennock is the general superintendent and electrician of the company.

Chinese Telegraph Service.—The launch service between Sharp Peak and Foochow has been resumed. Telegrams for Foochow, written either in code or plain language, will be accepted at the risk of the sender.

Mr. Fawcett and the Liverpool Telegraphists.—A largely-attended meeting of Liverpool telegraph clerks has been held to consider a reply which has been received from the Postmaster-General respecting a memorial they recently forwarded to him asking that work done on Sunday should be paid for as overtime. A resolution was unanimously agreed to protesting against the adverse decision of the Postmaster-General as unjust, and declaring that every legitimate means should be taken to obtain redress of the grievance.

The Commercial Cable Company.—Messrs. John Elder & Co. launched on September 18th, from their Fairfield shipyard, Govan, a steel twin-screw steamer, which has been designed and built by them to the order of the Commercial Cable Company (Mackay-Bennett cables), for the purpose of repairing and keeping in order their new Atlantic cables. The steamer is constructed of mild steel, the scantlings of which are in excess of Lloyds' requirements for the highest class of three-decked ships, while the work has from the commencement been subject to special survey. The dimensions of the steamer are :—Length over all, 270 feet ; length between perpendiculars, 250 feet ; breadth extreme, 40 feet ; depth, moulded, 24 feet 6 inches ; and the gross tonnage is about 2,000 tons. She is built with an elliptic stern, and the stem is curved forward in the form of a cutwater, so as to prevent the cable fouling the fore-foot. She has also a short poop aft, a long bridge-house amidships, and a top-gallant forecastle. A double bottom, built on the cellular system, divided into four water-tight compartments for water ballast, is fitted right fore and aft, and in addition to this, water ballast can be carried in the cable tank cones. The number of water-tight bulkheads is five, four of which extend to the upper and one to the main deck. Large bilge keels are fitted, so as to reduce the rolling of the vessel when laying cables in heavy weather. A rudder is fitted at each end of the ship, with means of locking the same from the upper deck when not required for manœuvring. The tanks for stowing telegraph cable are three in number, two of them placed forward of the engine and boiler space and one aft, and their collective capacity is 27,200 cubic feet. Paying out and picking up machinery is carried on the upper deck ; the bows and stern are furnished with strong iron girders, which project, and carry the picking up and paying out sheaves. The vessel will be schooner-rigged, having double top-sails on the fore mast. Accommodation for the captain is provided in a deck-house forward of the poop, which house also contains the saloon entrance. The saloon is on the main deck aft, with state rooms on each side for cable engineers or passengers, one state room being very large and handsomely fitted up in hard wood for the use of the owners. Ship's officers and engineers are berthed in side-houses under bridge deck, and a continuation of the engine and boiler casing contains the galley and a large testing-room, fitted with batteries and appliances for testing cable. The crew's quarters are in the top-gallant forecastle, and the firemen's on the main deck forward. Twelve cable-men are berthed in two rooms on the main deck, one on each side of the main cable tank, while the remainder of this deck is used for workshops and cable store-rooms. Small tanks for the stowing of grapnel and buoy ropes and stowage space for grapnels, mushrooms and spare gear for the cable machinery, are arranged on the lower deck in the hold. On the forward end of the bridge deck is placed a house containing two chart-rooms for the use of the captain and officers, and on the flying bridge there is a small steering house. The steamer is fitted with a powerful steam capstan windlass and two horizontal steam winches. The steering gear for the forward rudder is a hand-screw gear, and the after one a combined hand or steam gear. An efficient system of telegraphs is provided for manœuvring the ship, as well as for the working of the cable machinery. The vessel will be fitted with two sets of compound inverted cylinder engines, each with two cylinders, one high-pressure cylinder, 25 inches in diameter, and one low-pressure cylinder 50 inches in diameter, with a stroke of three feet. The high-pressure cylinder has a valve of the equilibrium piston type, and for the low-pressure cylinder has an ordinary double-ported slide valve. These valves are worked by the usual double eccentric and link motion. The surface condensers are placed at the back of each engine, the water being supplied to them by one of Messrs. W. H. Allen & Co.'s centrifugal pumps. The air feeds and bilge pumps are worked by levers connected to the piston-rod crossheads of the low-pressure engines. The steam is supplied to the engines by two cylindrical single-ended multitubular boilers, each of which is fitted with four of Fox's patent corrugated furnaces. The boilers, which are made entirely of steel, are constructed for a working pressure of 100 lbs. per square inch. As the vessel left the ways, she was named the *Mackay-Bennett* by Mrs. Mackay. The steamer *Mackay-Bennett* will probably be ready about the date of the completion of the second Atlantic cable of the Commercial Cable Company. The whole of the cable work in connection with this company has been very successfully carried out, and the fact that its offices on both sides of the Atlantic are already organised, and that its repairing ship is now ready, speaks well for the general management. Mr. George Ward, who has been appointed the general superintendent on the American side, is recognised in New York as the man who made the successful traffic arrangements for the Direct United States Company, when this company was competing with the Anglo-American line, about nine years ago. This successful management led to the Direct United States Company, when the working arrangements were made, getting a much larger proportion of the receipts than should have fallen to any single cable. It is well known in London that during the competition with Jay Gould's, the Direct United States cable, under Mr. Ward's management, was selected as the cable for maintaining the preferential rate, as the speed of transmission through it, between London and New York, has always been greater than through the other lines. When the Mackay-Bennett cables are opened to the public, it is probable that their speed of transmission between London and New York will be even greater than that of the Direct United States cable, on account of the landing on the American side being closer to New York city than that of any of the existing cables. The Baltimore and Ohio Telegraph Company will be sure to give an excellent service between the principal towns in the United States and New York, and so form a good feeder to the new cables.

New Source of Caoutchouc.—We read the following in the *India Rubber and Gutta Percha and Electrical Trades Journal* :—We understand that the attention of the Indian Government has been drawn to a plant common in Southern India, and from which abundant quantities of pure caoutchouc can be obtained. The name of the plant is *Prameria glandulifera.* It comes originally from the forests of Cochin-China, where its juice is often employed as a medicine by the Annamites and Cambodians, The Chinese call it Tuchmig, and it is a frequent ingredient in the materia medica of China, being imported from Cochin-China for this purpose. On breaking a branch of this plant one sees in the interior the caoutchouc, which can be drawn out in threads, as in the case of the "landelphia" of Eastern Africa. M. Pierre, director of the Botanic Garden at Saigon, believes that the cultivation of this plant would constitute a very valuable addition to the forestal industries of India.

International Forestry Exhibition, Edinburgh.—Messrs. Robey & Co., of the Globe Works, Lincoln, have been awarded the highest award, viz., a gold medal (first class), for engines and machinery.

Race Between Electric Launches.—The trial trips of the *Australia* and the *Electricity* were brought off successfully on Saturday last. The *Electricity* is a steel boat, 25 ft. long, 5 ft. beam, built by Yarrow about a couple of years ago, and is fitted up by the Electrical Power Storage Company, 50-H.P. accumulators being placed under the seats and decks. The motor is a Siemens D_2 machine, weighing 658 lbs., and is coupled direct to the screw shaft, driving a Yarrow propeller of 18 in. diameter, having a pitch of 11 in., which is capable of being worked up to a good speed for seven or eight hours. For the trial under notice only forty cells were charged, to reduce the power to the stipulated conditions, viz., five horse-power. During the competition the vessel was under the charge of Mr. F. Thornton, manager of the E.P.S. Company, and carried eight passengers. The *Australia* is a new boat, just completed, built of mahogany to the order of Messrs. Stephens, Smith & Co., for a Melbourne firm, by Messrs. Forrest, of Millwall; length, 25 ft., with a beam of 5 ft. 7 in., and altogether a very handsome craft. The accumulators are placed in a box fixed in the bottom of the vessel, and supply the current to a Reckenzaun electro-motor weighing 390 lbs., and taking a current of 37 ampères from 50 E.P.S. accumulators of the ½-H.P. type. This motor drives a screw propeller of the same dimensions as the one used in the *Electricity*. The *Australia* was under the direction of Mr. A. Reckenzaun, the patentee, and carried a similar number of passengers to the other launch. The accumulators in both vessels were charged on Friday evening by means of cables leading from the dynamo room of the Storage Company to the boats lying in the river. Everything being in readiness they left the wharf on Saturday at eight minutes to two, and proceeded to the middle of the river, and five minutes later they started for Charing Cross Pier, it being high water at the time. In the run up everything went well, there being but little perceptible difference in the rate of speed of either, the new boat, if anything, having a shade the best of it, arriving first at Charing Cross by a couple of lengths at 2 hours 32 min., being thirty-five minutes from the start, and soon started on the return journey, arriving at Waterloo Bridge at 2 hours 41 min. Between here and London Bridge, being on the top of the tide, there was a lot of craft about, and both vessels were eased, and coming down the pool the new boat had to stop, owing to her thrust bearing getting hot. After cooling it down the boats started again, and ran right down to Greenwich, reaching the pier at 4 hours 12 min., when all landed, highly pleased with the success of the trip.

Military Signalling by Means of the Electric Light.—A method of military nocturnal signalling has been devised by a Russian, Captain Kostovich, and successfully tested at Cronstadt. To a small captive balloon is suspended an Edison electric lamp, which, by means of connecting wires, can be kindled and extinguished at will by an operator stationed on board ship or in any other convenient position, a series of such extinctions and re-ignitions being employed according to a telegraphic code.

Personal.—We very much regret to observe that, in consequence of ill-health, Mr. G. H. Stayton, who has been for nearly 10 years surveyor to the Chelsea vestry, has been obliged to relinquish that office. Mr. Stayton has long taken great interest in matters relating to electric lighting, and his reports upon the subject to his vestry have possessed considerable value. The most recent, respecting the experiments in house-to-house lighting at Colchester, was presented at the meeting of the vestry on the 16th inst., and is published *in extenso* in our other columns this week.

Crystal Palace International Exhibition.—We notice that Messrs. Robey & Co., of the Globe Works, Lincoln, have been awarded at the above-named exhibition the highest award, viz., "Diploma of Honour," for their patent "Robey" winding engine, compound "Robey" engine and other machinery.

The Correlation of Physical Forces.—Referring to the proposed experiment of "Musicus," we would beg to point out to our correspondent "G" that he has omitted to sign his name or to enclose a card. We cannot publish anonymous correspondence however valuable or interesting.

A friend writes:—If "Musicus" will look back to a paper by A. Jamieson on "The Action of Selenium in the Photophone," page 92, the TELEGRAPHIC JOURNAL, 1881, he will find a plan which was tried very similar to that which he proposes in your issue of last week.

Electrical Power Storage Company, Limited.—This company is offering its accumulators, manufactured under the patents of Faure, Sellon, Swan, and Volckmar, at new quotations, which may be learnt on applying to the company for its price list.

The Watt and Horse-power.—The Electrical Conference at Philadelphia approved the suggestion made by Mr. W. H. Preece in his paper before the British Association at Montreal, that the horse-power be raised to the equivalent of 1,000 watts or 44,000 foot-pounds.

The Telephone in Russia.—Although the telephone has become an established fact in several of the largest Russian cities, notably St. Petersburg, Moscow, Odessa, Riga, and Warsaw, it is making but little progress elsewhere in the country. St. Petersburg itself is traversed in every part by at least 1,500 versts of wire on the Bell system. The works and factories in the quarters of Viburg, Krestovsky, and Old Petersburg are all in connection with the central portion of the city, as are also the great government offices with the barracks, police courts, and prisons, so that orders from headquarters can be instantaneously communicated and carried out. The wires now extend to the fortresses of Gatschina and Peterhof, and the large smelting works of Pontilow and Alexandrovsky, some eight or ten versts distant, correspond directly with the Nevski Perspective and the Morskaia. An office has been opened for the public, who can send a message for 25 copecks.

The Megametre.—Some time ago M. d'Abbadie proposed in the French Academy of Sciences the adoption of the term *mégiste* to represent the fourth part of the terrestrial meridian, or a length of 10,000 kilometres on the French metric system. In order, however, to have a term more in accordance with the nomenclature of the multiples and sub-multiples employed to-day by electricians, M. Hospitalier has made an amended proposition to the effect that the word megametre should be used instead.

CITY NOTES.

Edison Electric Light Company, Limited.—The creditors of this company are required, on or before the 31st October, to send their names and addresses, and the particulars of their debts or claims, to George Sneath, 44, Gresham Street, E.C., chartered accountant, the liquidator of the company.

Compagnie du Télégraphe Sous-Marin Entre la France et l'Angleterre (Societe Carmichael et Cie).—The gross receipts for the year ended 30th June last amounted to 3,194,116 francs, being a decrease of 168,531 francs as compared with 1883. Payment was made on the 1st of September of a dividend of 7¼ per cent., less 3 per cent. tax, making, with the interim distribution of 8½ per cent. in March last, 15¾ per cent. for the year, a balance of 2,867 francs being carried forward.

Provincial Brush Electric Light and Power Company, Limited.—A petition has been presented to the court to confirm the resolution for reducing the subscribed capital of the company from £99,205 to £54,562 15s., making the total capital £155,357 15s.

United Telephone Company, Limited.—The *Times* money article last Saturday spoke of the increased demand for the shares of the United Telephone Company, which advanced to 12¾—a rise of ⅝ from the previous day.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 19th were £2,875, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

NEW PATENTS—1884.

12514. "Electric alarm apparatus." H. A. MAVOR. Dated September 17.

12516. "Galvanic batteries." P. D'HUMY. Dated September 17.

12517. "Galvanic batteries and carbons for same." P. D'HUMY. Dated September 17.

12524. "Electric gate locking apparatus." E. E. EVANS. Dated September 18.

12553. "Electric belts and corsets." B. WECKSTER. Dated September 18.

12623. "Coupling for electric wires used in lighting railway carriages, &c." R. W. VINING. Dated September 20.

12626. "Electric arc lamps." A. PFANNKUCHE. Dated September 20.

12629. "Dynamo-electric machines." A. E. WADLEY. Dated September 20.

12651. "Telephone apparatus." C. A. GISBORNE. (Communicated by T. N. Gisborne and D. H. Keeley.) Dated September 20.

12654. "Electric governors." J. SWINBURNE. Dated September 20.

12675. "Carbons for incandescent electric lamps." M. EVANS, F. WYNNE. Dated September 22.

12725. "Process for electrolytic extraction of copper from its ores." E. MARCHESE. Dated September 23.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Letters, &c., for the "Correspondence" columns should arrive not later than Tuesday morning if they are desired to appear in the following number, such communications to be addressed to the "Editors," ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C.

Letters respecting Advertisements, Subscriptions, &c., should be sent to the "Publisher," ELECTRICAL REVIEW, at above address.

ADVERTISEMENTS.

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Cheques and Post-office Orders (on Chief Office, London) to be made payable to H. ALABASTER.

CORRESPONDENCE.

"Electrical Classes."

In reference to the communication in your last issue of W. S. (whose initials I do not recognise as those of any former pupil recently in this school), I cannot tell to what period he can refer in his expression, "During my experience." From the wording of his letter, however, I presume that this period would probably be within the years 1882 or 1883. Now in the former year I find noted in our register the names of 20 gentlemen who obtained appointments in the Submarine Telegraph Service alone, and 10 names are so noted as having obtained such appointments in the latter year. Many other engagements were obtained of which no note was made. If this be the case, and I invite you, Mr. Editor (or your representative), to verify the fact, the injurious assertion made by W. S. is not merely disproved, but is shown to reflect discredit only on himself. I am glad to state that, in contrast to statements such as this, we frequently receive testimony to the effect that old pupils of ours, well able to "hold their own," are to be found wherever any of the applications of electricity are being carried into effect.

W. N. Tiddy.

Referring again to our register, so far back as the year 1877, I find only one name with initials as above. Should this be the name of the writer of the letter above referred to, I can only say that he was one of our "hardest bargains," and that he has stated what he must know to be untrue, since, during the year in question, we have the names of 10 gentlemen who entered the Submarine Telegraph Service (this being the particular branch referred to) with our recommendation.

The School of Submarine Telegraphy and
Electrical Engineering,
12, Princes Street, Hanover Square,
London, W.

It is surprising that such a letter as that appearing in your last issue should have been written by any pupil of the "School of Electrical Engineering," Hanover Square. I, myself an old pupil, know of several men who have obtained appointments in various submarine companies after passing through a course of instruction at the above-mentioned institution.

Edward Raymond-Barker.

Brazilian Submarine Tel. Co.,
London, *25th Sept.*

Permit me, as an old student of the School of Telegraphy, to criticise the remarks made by your correspondent, "W. S.," relative to the above school, in your issue of September 20th.

I am led to do so simply from a love of justice, and on the part of my friends and former fellow students who have obtained appointments in the Submarine Telegraph Service through the very instrumentality that "W. S." appears so anxious to ignore, but who, owing to their residence abroad, will not perhaps see his letter, or will be unable to reply, at least, without some delay.

Quoting from your correspondent's letter, he commences by saying that "It would be interesting to learn how many of the 3,000 pupils referred to in your article have obtained appointments in the Submarine Telegraph Service through their instrumentality." As this part of his letter could have been so easily answered by enquiries at headquarters, had he not precluded himself from satisfying his love of analysis by the course he has now adopted, I shall pass on without further comment to where he mentions his own experience—apparently a bitter disappointment.

Being in ignorance of the period to which he refers, as unfortunately he has inadvertently, or purposely, omitted the date, I can merely state my experience. As, however, I have no reason to keep back the date, I have much pleasure to inform your correspondent that I can at once tot up the names of five students, at least, who obtained appointments in the Submarine Telegraph Service in my time—*i.e.*, in 1880—besides others who joined the telephone and electric light companies, and are now holding prominent positions; and if my memory serves me aright, there were a batch of about seven successful telegraph students in the previous year—*i. e.*, 1879—who secured similar appointments after duly qualifying.

It only remains to add that, after duly concluding my course, I (amongst many others) secured an appointment in the electric light branch of the profession through the same instrumentality.

Trusting that the above may be of interest to "W.S.," and that you will insert it in your valuable paper as confirming your own just remarks, but at the same time apologising for taking up so much of your space.

W. H. T.

September 24th, 1884.

[We have examined the register of the School of Submarine Telegraphy and Electrical Engineering from the year 1876, and we find that very many students have obtained excellent and lucrative appointments. We have, therefore, no hesitation in stating that the letter signed W.S., which appeared in our last issue, must have been written under a misapprehension of the true facts of the case.—EDS. ELEC. REV.]

THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XV.—NO. 358.

THE DANGERS OF ELECTRIC LIGHTING.

THE fatal accident at the Health Exhibition last Saturday will doubtless be made the most of by the advocates of the "low tension systems" of electric lighting, and again, for a time, dynamo machines having a high electromotive force will be looked upon with distrust, if not with positive fear. That there is a risk in employing such apparatus we have frequently pointed out; but the risk might be much reduced if greater precautions were employed for the safety of those whose duty it is to be in constant proximity to the machines. Although as yet unacquainted with the particulars of the accident, we think it is not out of place to submit that the terminals of a machine should be so placed that it would be impossible for a workman to come in contact with both at the same time. In addition to this, various dispositions of the brushes or collectors and of the conducting wires will readily suggest themselves as means of reducing the chances of shocks being received.

That we shall, so long as installations of the kind are insufficiently looked after, hear of occasional fatal accidents is very probable; but this need not cause a scare against high-tension machines, which must be used if electric lighting or the electrical transmission of power is to make any great headway. We do not think, however, that engineers have yet given enough attention to this subject: the possibility of accident should be reduced to a minimum where such machines as the Hochhausen 25-lighter, which is said to have occasioned the fatality, are used. In mines, powder magazines, and in almost every place where danger to human life is one of the conditions involved, everything that man's ingenuity can furnish is forthcoming for the protection of employés. Indeed, in powder magazines we are under the impression that the workmen are obliged to wear a peculiar kind of shoe or slipper whilst at their duties. Had the poor fellow at the Health Exhibition any protection in the form of special gloves for his hands?

It would be useful information if we could gain possession of certain electrical data in connection with this sad affair. It is not enough that we know the electromotive force at the terminals of the machine or between the binding screws of each lamp: we require to know the exact difference of potential at that part of the circuit whence the shock was derived. Even this would be but of little direct assistance unless we ascertained the resistance offered by that portion of the man's body which formed the derived circuit. That resistance of this kind varies enormously with the state of the contact we know, and therefore the actual current strength which proves fatal to human life can only be a matter of speculation.

Enough has been said to draw attention to a matter which now demands more serious consideration than it has yet received; and we trust that one result of last Saturday's fatality will be to suggest to electrical engineers means whereby they may render the recurrence of such an accident a matter of impossibility.

THE PHYSIOLOGICAL BEARING OF ELECTRICITY ON HEALTH.*

By W. H. STONE, M.A., M.B., F.R.C.P.

IT is now about two years since I had the pleasure, in conjunction with my colleague Dr. Kilner, of bringing a paper before this Society, in which we tried to lay down some rudimentary basis for physiological measurement of electricity; and I am happy to acknowledge in beginning that the origin of that paper, as it is of this which follows, was due to a former president of this society, Colonel Webber. The former paper was only preliminary, and intended to clear the ground; even in this I cannot for one moment pretend to have reached anything like finality. A few more observations have been made by as accurate measurement as can be obtained, so as to lay, if possible, something like a solid foundation for what has hitherto been entirely built on sand.

In the excellent practical paper † which we had this morning, which was followed by one of the most agreeable discussions I ever heard, a good deal of the ground was cleared which otherwise I should have attempted to cover, and I may therefore take you at once to the physiological relations, and I may say that I shall not speak about lightning accidents. I shall only incidentally speak of it when treating of high tension currents. The same thing applies to sight. The injuries to sight, no doubt from electric light, although ultimately due to electricity, depend more on the intensity of the light and the associated motions in space which light carries with it, than on anything which belongs to it as electricity. We have in electric lighting two different things, the two extremes of the spectrum—we have incandescent lights, and we have arc lights. The dangers of the incandescent lights are evidently derived from heat vibrations; the dangers of arc lights are as evidently due to actinic and ultra-violet vibrations.

Perhaps I may be allowed to mention a convenient appliance (for this society always has been, and I hope will long continue to be, a practical society), in which, with the assistance of Mr. Gardner, of Messrs. Baker's, of High Holborn, I have somewhat modified the usual goggles.

The goggles sometimes have to be used for incandescent lights, and sometimes for arc lights. They have blue fronts to them, which keep out the heat rays very fairly; they have also red sides. When I look at an incandescent light, and my eyes get irritable, and the conjunctivæ inclined to be troublesome, I use the blue goggles; when at an arc light I shut the sides down and use both. I strongly recommend these to electrical engineers.

We may now proceed to speak about the subject of my syllabus. It is there said that electricity, as at present used, is at once a source of danger, a possible cause of sickness, and a remedy. What I shall mainly consider will be, in the intermediate space between the danger and the remedy, certain means of measuring the risks of danger, and obtaining something like a basis for definite facts. I was present as a boy, I am proud to say, at Faraday's lectures and experiments. I served as the subject for some few of them; and all that has occurred since, these enormous currents which we are now making use of, were of course then practically unknown. But while electricity has been making bigger strides than any other physical science, electricity as applied to physiology has marvellously hung back, and it is certainly still in the anti-Faradaic period. For this I have given some reasons: one is in the syllabus, that the knowledge of physics and the knowledge of physiology is rarely united, and is to a certain extent incongruous, I might even say antagonistic. The mind of the physiologist is not the mind of the physicist, and there is occasionally a little heating from friction between the two.

There is another reason for it. It is a good thing for the world at large, it is a good thing for science at large, when one very big man comes and occupies a field. He does all the work that can be required. He settles the induction, as Faraday used to say, and then he leaves the rest to the computers. This was done to a great extent for electricity by Faraday himself. But it sometimes happens that a man is too big for his place; and we had in physiology one of those men, Duchenne, of Boulogne, whose work has not been properly appreciated up to now. But this work was not electrical. He experimented with a very rough induction coil;

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* Read at the Conference of the Society of Telegraph Engineers and Electricians, Health Exhibition, July 4th, 1884.

† Electric Lighting in Relation to Health, by R. E. Crompton.

and I recollect him well in the Paris hospitals—a little man, energetic like a Frenchman, not grand to look at, but full of work—trotting about examining all the patients with this curious induction coil of his. It was a very bad coil, but it had the gift of exciting muscles; and by testing patiently and carefully for years a number of muscles individually with small pointed conductors by means of his induction coil, which was practically only an irritator, only an electric needle which he stuck into these muscles, he accomplished a great work. He isolated two or three distinct diseases not isolated before, but which are now well known. That work was physiological, not electrical. Now that old-fashioned induction coil is a very complicated, a very uncertain, and a perfectly unmeasured source of force. We do not know—at least we have not known—the least in the world what it is doing. We know that it tickles up the muscles into activity, and we know that if they do not respond naturally, it is an indication of some pathological change in the human body. But that is not electrical; it has got the name of electricity without being electricity. As to electricity pure and simple, I am sorry to say I see great evidence that the medical world is somewhat behindhand.

In a medical periodical the other day I found a review of a work on electrical medicine. The first statement which it begins with, as a sort of flourish of trumpets, is, "There is no mode of measuring alternating currents." I have not been able to recover that extremely foolish statement, and therefore I will not say where I saw it, but see it I undoubtedly did. Only on the 28th of June an article on galvanic batteries for medical purposes appeared. This is written very much more *bonâ fide* than the others, and I dare say is in the main correct; but I find in this the following statement:—"The resistance of the body varies within wide limits—500 to 100,000 ohms." These are wide limits; I think they are wider limits than the Society of Telegraph Engineers would be willing to sanction. If you turn that into current or potential, see what would happen to the patient if during the experiment his resistance should vary from 100,000 ohms down to 500; the man would simply be burnt up alive. Therefore it is high time we should pay attention to this.

Now, to get something a little more precise. These come under the head of common errors or dangers. As to those to life and health, I might begin by stating that it is perfectly clear, from Mr. Crompton's excellent paper, that for the powerful currents we have been using the accidents and dangers have been singularly few; but it does not follow from that that we have a right from our present immunity entirely to disregard them, or that circumstances may not arise when they would become a very serious matter. Here of course I take my stand; and I shall appeal rather to my friend the excellent President of the College of Physicians for confirmation as a physiologist, when, speaking of the causes of danger, I say it is obvious that they are not only one. When I say only one, I mean the familiar cause of danger which we all know in shock from lightning. An instance of such danger was the unfortunate man at St. Petersburg who, being short-sighted, put his head too near where he was examining the discharge, and it struck and killed him. We know several such cases. The cause of these deaths is obviously shock. There is no *post mortem* appearance found, and they agree with cases of death from concussion of the brain. But, taking them generally, very high tension currents, such as lightning, seem to kill, by a shock affecting the nervous system and brain, instantly. Now, many of the deaths which have taken place have not been instant, and we must go further afield to find the cause of death. Two other causes of death seem to be indicated. There may be actual catalytic action, actual decomposition of the tissues of the human being; that decomposition I have once seen to occur. It takes place of course at one of the poles; in this particular case at the negative pole. Secondly, you may have that wonderful coagulation of the vessels of the body during life which the great Virchow has not only pointed out, but has brought home and made a household word to every physician. Now, under the definition of thrombosis of one of the larger vessels, such as the heart or the lungs, or the large system of arteries or veins, I believe some of the deaths which have taken place from electricity to be included. At any rate, from the very mutilated details which I can collect as to the death at Birmingham, where a foolish player in the orchestra seized hold of the terminals, it seems to me very much like a case of thrombosis. He became livid, and lived about three-quarters of an hour, which in a case of death by lightning would not have occurred. There was apparently a mixture of asphyxial and thrombotic symptoms, which I have no doubt the President of the Royal College of Physicians will recognise. Therefore I think we must be alive to that as a possible accident. But no doubt most of the cases have been from shock or syncope. The only accidents I have down of which I can get any details are the case at Birmingham, which I have disposed of, because the papers said the man lived three-quarters of an hour, and therefore it could not have been a death from shock; and then there was the celebrated Paris accident of the two foolish boys or men who tried to climb over the wires; there was the Hatfield accident, and then there was the accident on the Russian yacht. If any members of the Society can give me the details as to what were the particular classes of machines employed, and whether the currents were continuous or alternate, what was the tension and also the period at which the unfortunate sufferers lived after receiving the shock, it would be most valuable.

Chief among common errors, let me name imperfect contact. Any person accustomed to electric measurements will see immediately that the very hopeless statement that the body varies from 500 to 100,000 ohms must be a question of contact—it cannot be anything else; and I believe the differences experienced in the early days of medico-electricity have been that the contacts have been to a degree imperfect that the experimenters and all persons concerned did not in the least suspect. Everybody has known for a long time that the skin when dry is a very perfect insulator; in this country less so than in America.

The first question which presented itself to me was how to get rid of this delicate, this very thin but singularly perfect insulation, which prevents contact and raises the resistance sometimes to 100,000 ohms. I thought simply first of making a hole in the patient, and some of my students allowed this. It was also done by Prof. John Morgan, of Manchester; but it is not agreeable, and on second thoughts I do not think I should allow it on myself again. I used the little hooks used by surgeons, called "serre-fines." I passed them through the epidermis, and the actual contact can be got in that way; but the patient objects, and I do not blame him. I have tried oleate of mercury, which is a good conductor, and that answers very well indeed; but, unfortunately, that is transferred into the patient, and mercury is a somewhat powerful agent. Then I thought of strong salt and water; and with strong salt and water I may honestly say I have succeeded. This method was brought before the British Association; but, besides a good conducting and harmless solution, it obviously showed itself to me that through an imperfect conductor like the skin—a variable conductor—the size of the contact must be geometrically infinite as regards any possible current it should have to transmit. That, I think, I have achieved by using one of these long leaden electrodes rolled in surgical fashion round the hand. That, with salt water underneath in some form—say, a piece of flannel—acted so well for my small currents that the skin resistance, and the cause of failure as I hold it to be, was brought down, if not to nil, to a minimum. The argument which I should rely upon here would be this. A patient of mine unfortunately died. I had examined him electrically before that sad event, and had got 1,100 ohms resistance by means of lead electrodes wrapped round his feet. After death, when the poor man could suffer no more from my researches, I passed two long silver needles, intended for curing aneurisms, three inches deep into the soles of his feet—the plantar muscles—that is say, right through the epidermis into the muscular tissues; and, whereas the resistance had been 1,100 ohms through my large electrodes, it was 50 more through these long needles. Of course the 50 more was due to this, that I had been carrying the poles a little higher; the conductor was somewhat shorter, and I was passing the current through a little more human tissue than before, and the 50 ohms very fairly coincided with the extra distance. This showed that I had reduced the skin resistance, if not to nil, at any rate to a very small quantity. When these views met the eye of an excellent physicist and electrician, Prof. Dolbear, of Philadelphia, he wrote me a genial, hearty letter, in which he said he should not deny the fact, but he thought a man with his feet wetted in salt water was in an abnormal condition. He deserves great credit for the word "abnormal." There is no doubt about it; we do not all live with our feet wetted in salt water. Now we do not want to know the resistance of the skin, but of the tissues. We know that dry skin will run up to any resistance, and so will good insulators; but you do not want to know the resistance of a telegraph line when it is beautiful dry weather; it is the minimum resistance you want to know; and here I believe the physiological point involved is not the maximum, but the absolute minimum. Now when you take the resistance of the body, after getting rid of this imperfect contact, it comes down to very much less than what has been generally given. The 500 ohms which I quoted from a paper would not have been put in a year ago; it is a stolen arrow out of my quiver, because before that I never saw 500 ohms given as the resistance of the human body; but that it can under certain circumstances, especially those of raised temperature, sink to 500, I have not the smallest doubt, because I can give actual demonstration of the fact.

But there is another point that comes out. The resistance of the human body is not equal, or anything like equal or similar to high tension and low tension currents. If this be true, and it is one of the points I hope to go some little way towards proving, all our physiological work as to currents as physiological stimulants will have to be revised in the view of this constant being altered. What is the power of these various induction machines? We know only very vaguely; it has never been measured or allowed for. The induction machines of constant current vary in their effects, not only on account of the physiological differences in the body or electrical differences in the current, but because not so much gets through in the one case as in the other. Take any case I have here in my notes. The resistance of a particular patient, suffering from diabetes, using 6 cells of my bichromate battery of about 1·8 volts each, was from foot to foot 1,210 ohms, from right hand to foot 1,350 ohms, and from left hand to foot exactly the same number. To the induction current from this little coil which I have here, which I have measured and know perfectly the electromotive force, it was, as against 1,210, only 473 ohms. That cannot be an instrumental error. Then from the right hand to the foot, as against 1,350, it was 735. I made it 750, but I was not quite accustomed to the telephone in those days as a means of measuring two currents on a Wheatstone bridge, and I think that was an instrumental error, only amounting, however, to 15 ohms. I have since taken the resistance of a gentleman, an excellent clinical clerk of mine, a very praiseworthy student of St. Thomas's Hospital, and besides those merits he is 6 feet 3 inches high, and weighs 13 stone. From foot to foot his resistance was on the mean of many experiments 930 ohms.

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